OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

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

RESTRICTED

18771

DP/ID/SER.A/1432
24 January 1991
ORIGINAL: ENGLISH

STRENGTHENING OF THE MALAWI BUREAU OF STANDARDS

DP/MLW/85/005

MALAWI

Technical report: Industrial metrology testing*

Prepared for the Government of the Republic of Malawi
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Mr. Andrej Kuruc,
consultant in industrial metrology testing

Backstopping officer: K. S. Stephens
Institutional Infrastructure Branch

United Nations Industrial Development Organization
Vienna

* This document has not been edited.

V.91 20665

TABLE OF CONTENTS

1. ABBREVIATIONS

AD	Assize Department
ARSO	African Regional organization for Standardization
BIPM	Bureau International des Poids et Measures
ESCOM	Electrical Supply Commission of Malawi
GDP	Gross Domestic Product
GM	General Manager
ISO	International Organization for Standardization
MBS	Malawi Bureau of Standards
MECC	Malawi Electrical Calibration and Repair Centre (Zomba)
MISCOR	Malawi Iron and Steel Corporation
MK	Malawi Kwacha (1 US $ ≐ 2,6 MK)
MTIT	Ministry of Trade, Industry and Tourism
NCS	National Calibration Service
NLM	National Laboratory of Metrology
NMS	National Metrology Service
OIML	International Organization of Legal Metrology
QC	Quality Control
RI	International Recommendation
SA	South Africa
SUCOMA	Sugar Corporation of Malawi
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization

ABSTRACT

Project of the Government of Malawi:

Strengthening of the Malawi Bureau of Standards.

Number: DP/MLW/05/005/11-04 Duration: Two months.

Government Implementing Agency: Ministry of Trade, Industry and Tourism
Malawi Bureau of Standards

Executing Agency: UNIDO

Name of Expert : Andrej Kuruc

Duty Station : Blantyre

Expert was fielded on the project as Consultant in Industrial Metrology. His main duties were to identify the means and ways of initiating industrial metrological activities in the MBS, based on analysis of existing facilities and organizational structure for industrial metrological activities within the country. Technical specifications of the physical standards and equipment needed were also to be prepared.

Job Description, see ANNEX I.

2. INTRODUCTION

It is generally agreed, that the development of a National Metrology System is one of the most important provisions to enable economic and industrial growth with a high level of product quality. Such system has to ensure the traceability of measuring equipment to national standards. It also has to focus on calibration activities, development of appropriate measuring procedures and technological support to manufacturers and users of measuring equipment. These activities are sometimes referred to as industrial metrology.

Until now, such a national system does not exist in the Republic of Malawi. There were some provisions for establishing at least a part of such a system within the UNDP/UNIDO project of strengthening of the Malawi Bureau of Standards, namely Output 2:

2.1 Functional metrology laboratory capable of providing metrology services and supervision of quality control and testing activities within the MBS.

2.2 A qualified and trained specialist in metrology techniques and theory capable of running the laboratory efficiently.

2.3 Set of operational procedures (legal documents) on providing metrology supervision.

However the activities for the output were disigned improperly, not to mention that recruitment of only one additional national staff was foreseen. The funds allocated for metrological equipment were spent on other devices or cancelled, the budget line for an expert in Legal metrology was cancelled. In spite of these facts, it was decided to elaborate proposal for initiating industrial metrological activities in the MBS as a start for establishing the National Metrology System.

3. RECOMMENDATIONS

The realization of the recommendations as follows will create the basic conditions for arrangements and facilities for the testing and calibration of precision instruments, gauges and scientific apparatus, for the determination of their degree of accuracy and for general enforcement of law and order in the field of metrology, at it is stated in MBS Act (Cap. 51:02).

Recommendations to the Government:

1. To elaborate, approve and issue as soon as possible the new law (or Act) on Metrology to replace outdated Malawi Bureau of Standards Act (Cap 51:02) and Weight and Measures Act (Cap 48:04). The new law should clearly specify rights and duties of the organization responsible for its implementation - preferably MBS.

   Note: *The International Document No. 1* ***"LAW ON METROLOGY"*** *of International Committee of Legal Metrology (1975) could be used when drafting the new law. In addition to this document a special part of the law should deal with accreditation of calibration laboratories and establishment of an Accreditation Body with necessary authorization within MBS. The general rules for performing the assessment and accreditation of laboratories shall also be included.*

2. To strengthen the influence of the Government technical policy by promoting the integrated approach to quality control activities - standardization, testing, metrology. To achieve this, it is urgently recommended to establish the strong, omnipotent organization responsible for these activities in Malawi by merger of Malawi Bureau of Standards and Assize Department, extending at the same time their authority according to the new Law on Metrology.

3. To include the Development of Metrology Activities into the next Short Term Development Plan within the Total Quality Control Programme, assigning at the same time necessary funds to start activities in the field of primary standards and industrial metrology. The MBS shall be responsible for the implementation of the programme. Within this programme, the National Laboratory of Metrology and National Calibration Service shall be established.

4. To apply for the Malawi membership in the International Organization of Legal Metrology (Bureau International de Metrologie Légale, 11, Rue Turgot - 75 009 PARIS, France).

   NOTE: The member countries are supposed to pay annual membership fee according to the GDP or the population.

5. To consider, examine and negotiate the possibility of bilateral and/or multilateral funding of metrology. Possible donors: Germany, Sweden, UK, France, Japan, SA.

6. To present as soon as possible the request of Government of Malawi for further UNDP/UNIDO assistance according to the Draft Project Document (not later than February 1991).

Recommendations to the Malawi Bureau of Standards

1. To present the Draft Project Document to the Ministry of Trade, Industry and Tourism.

2. To have the construction plans for metrology laboratory building elaborated by architects under contract.

3. To assign or to recruit a staff member to study accreditation schemes, to be prepared for establishment of Accreditation Body within MBS and

implementation of NCS in two stages as suggested. A study tour abroad would be very useful.

4. To start looking for possible candidates to be employed in the metrology division.

5. To continue making the wide public and the industrial enterprises aware of the importance of standardization, testing and metrology through series of newspaper articles, radio transmissions and frequent seminars and workshops.

6. To look for possible donors of financial aid, equipment items and international expertise.

7. To follow-up the status of the fulfillment of Recommendations to the Government.

8. To introduce good laboratory practices to MBS laboratories especially meticulous cleanliness, plastic material covers for all the equipment not being used and better organization of laboratory work.

4 ACTIVITIES

After being thoroughly briefed in Vienna by the UNIDO backs topping officer, Dr Stephens, the Consultant arrived to Lilongwe on October 25, 1990. The briefing at the UNDP office was made by the JPO, Mr Kohtamaki on October 26. The Consultant had the opportunity to study some technical policy documents in the Library of UNDP. Arrival to Blantyre on the same day in the evening hours.

The mission at Malawi bureau of Standards started by initial discussion with Mr C W Guta, Quality Assurance Manager, as the General Manager, Mr A S Khulumula was abroad. The views on the mission were exchanged and initial information about MBS given. A Counterpart to the Consultant was assigned. As at present time there is no MBS staff member working in the field of metrology, Mr P I S Chiligo, Scientific Officer in the Materials Testing Laboratory was chosen for the task. The tour through the MBS laboratories was organized and the contents of the work plan discussed. The Consultant prepared the detailed work plan havingit preliminary agreed with Mr Guta and finally approved by the G M, Mr Khulumula. (See ANNEX II)

The first part of the mission was aimed to get the comprehensive information on the valid legislation concerning MBS ad Weights and Measures activities, to study organization schemes of MBS and Assize department, to find out existing or possible links with industrial, commercial or educational enterprises. At the same time, the Consultant tried to assess the attitude of the Government (in particular the Ministry of Trade, Industry and Tourism) towards problems of metrological activities. The attempts were made to find out the coverage of MBS activities in the Statement of Development Policies 1987-1996 or in some similar document. The previous UNDP, UNIDO and ARSO activities were also studied with emphasis on achievement of outputs.

The next part of the mission was spent by technical visits to the total of 24 enterprises of industrial, educational and research character with purpose to be able to assess the needs and possibilities of industrial metrology in Malawi, to discover any organizational links or to be able to suggest some.

The original list of enterprises was suggested by Mr Chiligo and amended according to the Consultant's requests. The time planned originally for the visits had to be extended due to occasional problems with transportation and the number and location of the enterprises. It can be said that the information gathered during the visits presents a well designed cross cut through the economy of Malawi, having included smaller and higher organizations, private and governmental sector etc. The findings of the mission can be therefore considered as characteristic for the whole economy of Malawi. Additional information was gained at the exhibition on occasion of Industrial Day of Africa

The Consultant prepared the Questionnaire on calibrating facilities and needs, distributed during visits. (See ANNEX IV) However, in spite of numerous interventions, only a few organizations cared to fill in the forms and to send them back to MBS. The information on status of measuring equipment and needs and possibilities of its calibration is then based on direct findings in the respective organizations and could not be evaluated quantitatively with regard to fields of measurements. Another important source of information are the results of survey made by Assize Department upon request of MBS. Some 43 organizations were contacted. The information gathered was divided into groups according to the type of measurements and evaluated. The results – see ANNEX V. The organizations, however, do not represent the best choice of Malawi Industrial enterprises. Some 15 Secondary School-type organizations are included and their measuring equipment, used only for educational purposes, is of secondary importance regarding establishment of calibration facilities.

About the mid of mission the meetings at the UNDP office and Ministry of Trade, Industry and Tourism were evoked by the Consultant. The Deputy G M, Mr Guta also took part in the discussions.

Upon request of G M, the Consultant elaborated the sketches of new laboratory building, including layout of laboratories offices and auxiliary premises, layout of laboratory furnitures and installations, requirements for the respective laboratories, sketches of basic laboratory furniture (benches, racks etc.) See ANNEX VI. Technical specifications of the

physical standards and the equipment were prepared. (See ANNEX VII).

A proposal for Establishment of National Calibration Service in two stages was elaborated, the first stage using the existing facilities and needing only legislation, the second stage providing for in-the-country traceability and extended calibration facilities after National Laboratory of Metrology establishment.

A one day seminar for participants from Commerce and Industry on basic concepts of metrology, with emphasis on relationship of metrology and quality control, importance of instruments calibretion for accurate measurements and practical examples was realized.

A round-table discussion with higher staff members of MISCOR was held on December 11, 1990.

After debriefing at the UNDP office in Lilongwe, the Consultant left for Vienna on Sunday, December 16, 1990 to be debriefed at UNIDO Headquarters.

A Draft Project Document according to the rules of UNDP/UNIDO (institution building) to establish National Laboratory of Metrology has been elaborated by the Consultant.

4.1 Technical Visits

4.1.1 W T Avery (Limbe)

The company has, in fact monopoly in selling, repairing and for -calibrating balances, scales, weighing platforms, weighbridges, flow meters in Malawi. The weighing instruments, after installation or repair, are for-calibrated. The official act of assizing the instruments, including the seal is performed by the staff of Assize Department. In the case of flowmeters, the oil companies perform the calibration. The petrol selling pumps are again officially assized by the Assize Department. The company started recently the installation of loading cells, however, they do not perform any direct repair except their replacement.

From the company, this important information on estimated number of weighing instruments in Malawi was received:

Weighbridges (capacity 5 000-100 000 kg) - total number	56
Steelyard P/Form Scales	5 000
Dial P/form	500
Self Indicating Counter Scales	10 000
Electronic Counter Scales (including Platform Scales)	3 000
Spring Balances	6 000
Counter Scales	10 000
TOTAL	34 556

No information on total number of laboratory balances was available.

The company registers also 20 material testing machines. A request for calibration of weighbridge testing unit (truck) was expressed.

Traceability: The working standard weights are calibrated (or verified) either by an international representative of AVERY during his round-trip through African countries, or by Assize Department.

4.1.2 **Malawi Electrical Calibration and Repair Centre** (Zomba) The Centre is operating under Post Office Administration. It has a very ambitious programme:

1. To set up and maintain standards of all electrical parameters that require to be measured;

2. To provide a calibration service based on these standards, for electrical/electronic test equipment used in Malawi;

3. To provide an initial calibration and/or evaluation service for all new electrical/electronic test equipment purchased for Government use.

The equipment of the Centre is primarily designed to help to calibrate the telecommunications equipment. The facilities for secondary standards work on electrical units are not so well equipped. They enable to perform some DC calibrations (based on sets of standard cell), AC calibrations (thermal transfer standard), frequency counters, capacitors, inductivity standards, resistors. However, the resistors are not calibrated at present

because of lack of silicon oil and frequency measurements would need the cesium standard and/or rubidium standard.

The Center has good premises, laboratories are temperature controlled (23 ± 1 °). However, the air conditioning of the standards laboratory (20 ± 1 °) was during our visit out of order. A valuable activity is repair service for customers. The repair workshop is well stocked by spare parts and repair time is very short. Some administrative problems are due to the fact, that the Centre is not in the direct line of interest of Post and Telecommunications. A possible merger with MBS would be certainly welcome by the staff members.

Traceability: All the equipment is supposed to be calibrated by British Calibration Service. The idea of having standard cells to be sent abroad by mail is, however, not the best one and will result, most probably, in their serious damage.

4.1.3 **Electricity Supply Commission of Malawi** (Chichiri)
The laboratory performing the calibration of energy meters is the part of electricity producing organization. Energy meters are excerpted from the Weights and Measures Act in spite of fact, that they are used in the trade. The laboratory calibrates approximately 5000 energy meters per year, either by direct comparison with a secondary standard (Landis and Gyr, Swiss) or by amps x time method. Time is then measured by a not calibrated stopwatch. There are two test benches, one for 16, another for 24 energy meters. When received, the old energy meters are dismantled, necessary parts replaced, completed and calibrated. When installed, all screws are assured by shelac, covers provided by seals (seal pliers).

Traceability: Very inconsistent - secondary standard calibrated in Swiss, measuring transformers and Ameters in South Africa, wattmeters in UK. Working meters (AV-meters, clip-on meters) in Zombe. A need of calibration of dead weight pressure gauge was expressed.

4.1.4 **Blantyre Water Board** (Chichiri)
The laboratory is situated in the compound of Blantyre drinking water reservoir. None of instruments used in

the laboratory work for analysis of water samples had ever been calibrated (balances, thermometers, pH-meters).

From the view point of calibration activities, the laboratory is testing or checking all the new watermeters and repairing and testing the old ones. The total number of checked watermeters is 1200 per year. Similarly to energy meters, water meters are excerpted from the Weights and Measures Act. Another part of Water Board activity is annual production of some 1700 water buckets used at 72 water selling points.

There is no calibration performed - a direct conflict with Weights and Measures Act.

Traceability: Nil. There are many other measuring devices, all of them used without any calibration. (Balances, scales, pressure gauges, measuring tanks).

4.1.5 **The Polytechnic (Blantyre)**

The Polytechnic is part of the University of Malawi. It has three faculties: engineering (mechanical, electrical, civil); commercial and applied studies. The Consultant found that this is the only institution in Malawi, where you can find the word metrology. There is a metrological laboratory at the faculty of mechanical engineering. The laboratory is satisfactorily equipped by sets of slip gauges, profile projector, 3 vertical comparators, small (30 cm) universal length machine, a Talysurf 10-roughness measuring instrument, deadweight pressure gauge, sets of micrometers, calipers, dial indicators. For civil engineering, there is equipment for testing of concrete, soils, tiles and bricks. The equipment was in no excellent condition, showing marks of corrosion, slip gauges without conservation layer of vaseline.

Traceability: Nil. In the other departments, usual measuring equipment as balances, thermometers, barometers can be found, all for them without calibration.

The interest of providing services for customers outside was expressed, especially in the field of non-destructive testing.

4.1.6 Meteorological Department (Chileka Airport)
This is one of 25 main meteorological stations, there are 20 additional ones. In the past some attempts were made to equip the laboratory for calibration of meteorological equipment. There are suitable Hygrometer Testing Chamber (Theodor Friedrichs), thermobath for testing of thermometers (SIAP) and Pressure (barometer) Testing Chamber (Theodor Friedrichs).

Traceability: Nil. None of working standards used (thermometers, barometers, hygrometers)has any form of calibration. Laboratory is equipped also for testing of electrical/electronical measuring instruments, they have Multimeters, Oscilloscope, AF generator, FM/AM Signal generator, Electronic time counter, Insulation Tester, Transistor Tester. All these instruments are regularly sent to Electrical Calibration Centre in Zomba. Expressed interest in having all the equipment calibrated. Pointed out that many schools and other enterprises ask them to perform calibration.

4.1.7 Air Malawi (Blantyre)
The information is based on findings of Mr Manyale, ARSO metrologist (1989). In spite of fact that the concept of calibration is at Air Malawi very clearly understood, the company has no reliable facilities for calibration. Capabilities of their service laboratories are very limited and they can only perform non-critical calibration and measurement tasks.

Traceability: Non consistent. Some instruments sent for calibration to Europe, Zimbabwe, Kenya, etc., electrical/electronical instruments are calibrated in Zomba. The idea of developing comprehensive calibration and measurement facilities within Malawi Bureau of Standards is very welcome.

4.1.8 Carlsberg Malawi Brewery (Blantyre)
Most probably the best organized enterprise in Malawi. There is well established Quality Control system, starting from checking/testing the incoming raw materials, through in-process control up to final product control. An integral part of the system is metrology. For all the measuring equipment used, the calibration facilities are provided and calibration performed as a rule in 3 months interval. About every calibration the records are kept and calibrated instruments are labelled accordingly. Main fields of

deadweight pressure tester - which, however is not calibrated), thermometers (range -20 °C + 500 °C), hydrometers, dew-point meters, scales, oxygen meters and other specialized measuring equipment.

During the visit, the problem of special devices calibration were discussed. The question of non-destruction testing has been raised. Possibility of using the equipment of Polytechnic wa suggested.

Traceability: Questionable.

4.1.9 **SUCOMA** (Nchalo)

The Sugar Corporation of Malawi has a plant situated among big sugar cane plantations in Nchalo, some 90 km from Blantyre. Similar to Carlsberg, the importance of having measuring equipment calibrated is clearly understood. The instruments used in laboratories are checked thoroughly by experts coming from South Africa once a year. (Analytical balances, refractometers, pH-meters, chromatography etc.). Measuring equipment in production is checked (or calibrated) either by outside contractors as W T Avery for balances, scales, platforms, weighbridges or for electrical instruments in Zomba. Some of instruments are checked in the factory: e.g. about 500 pressure gauges against deadweight pressure gauge which again is not calibrated, thermometers against mercury-in-glass thermometer without calibration. Two meteorological stations are under supervision of Meteorological Department. The plant has also a mechanical workshop with typical engineering instruments as micrometers calipers, verniers, tapes. All of them are without calibration.

Traceability: Questionable. The idea of establishment the Calibration Centre in MBS was welcome as it would save costs of having the instruments calibrated by foreign experts or sending them abroad for calibration as it is sometime with laboratory equipment.

4.1.10 **Mobil Oil** (Blantyre)

The facilities of this petroleum products selling company are similar to the rest of oil companies in Malawi. The laboratory equipment (thermometers, hydrometers) is used without calibration. Storage tanks were originally installed by experts from South Africa, each of them has an own calibration chart Measurements are done by dipping measuring tape into

tank. Tapes - mostly 15 m are not calibrated. Tanks on vehicles are mostly calibrated by the producer, each is provided by a dipstick and a calibration chart . The flowmeters on the vehicles are not used.

Traceability: Nil. The special case are pump flowmeters, serviced by the company staff and assized by Assize Department. Similar it is with volume measures.

4.1.11 Plumbing and Engineering Works (Chichiri)
The company produces road and farm trailers, bus and truck bodies, low loaders, steel structures and has practically monopoly in Malawi on vehicle tanks production. Concept of calibration is not well understood, however, the company performs activities on completed products (tanks) which have character of calibration. Tanks are produced according to drawings consulted with Polytechnic. To assure uniformity, templates are used for oval tanks. Polytechnic cooperated also by computations of dipstick and calibration chart for every tank. The thorough check is made using the water flow meter calibrated by Water Board. Similar procedure is used by circular tanks. The tanks are not fitted by flow meters. Company is sufficiently equipped by measuring instruments for engineering purposes (tape measures, micrometers, calipers, dial indicators, verniers, pressure gauges), but all of them are used without any attempt of calibration.

Traceability: Nil

4.1.12 Petroleum Services Company (Limbe)
The production programme is similar to the P E W, with emphasis on storage tanks. Similar is also the attitude to calibration - it is neglected. The tanks completed are provided by dipstick and computerized calibration cart, but there is no attempt to check upon the reliability as it is with previous company.

Traceability: Nil

4.1.13 General Tinsmiths (Blantyre)
In addition to a normal "tinsmith's" production, the organization produces volume measures (0,5-1-5 l) or other dimensions according to the customer's specification. As these are used in trade, all of them are assized and stamped by Assize Department before

being sold. The working standards in the production are also assized by AD. The company expressed an interest in calibration of measuring tapes, micrometers, calipers, verniers.

Traceability: To Assize Department.

4.1.14 David Whitehead and Sons (Blantyre)
A well organized textile production factory, with clearly understood concept of calibration. They calibrate the length measuring device (measuring the fabrics produced) every morning by own *"standard"* cloth. Complained about limited calibration facilities in Malawi Asking for calibration of micrometers, callipers, tachometers, pressure gauges, force, flowmeters, pH-meters, tachometers an starch-content measuring equipment. The Consultant gave the information about the possibility of having their electrical equipment calibrated in Zomba.

The weights and belances are maintained by very and if necessary assized by AD, therefore there is some traceability.

4.1.15 Portland Cement (Blantyre)
The plant is practically only a packaging facility for current produced in a factory at Changaiume. Laboratory equipment is not calibrated. Seeks are served by Avery and assized every 6 months by AD.There are problems with semi-suitable packaging system.

The main factory has more measuring instruments (pressure gauges, thermometers, electrical meters) but without any calibration.

Traceability of mass measurements: Assize Department

4.1.16 Industrial Gases (Chichiri)
This industrial gases producing plant was constructed by experts from South Africa. All the tanks used for storage of liquid gases have original (SA) calibration. Pressure gauges used up to 200 kg cm^{-2} are checked against deadweight pressure gauge (as usual without any calibration). All other measuring instruments (thermometers, hydrometers, measuring tapes, micrometers, calipers) are "believed" to be correct when bought. Furthermore, the hydrometers use - conventional Twaddle scale, they are not metric.

Traceability: Nil.

4.1.17 Grain and Milling Company (Limbe)

The usual pattern of measuring instruments - laboratory and production. Weighing equipment in production is serviced and adjusted by Avery. There is an ambitious head of laboratory, trying to check or calibrate his analytical balances and thermometers, fighting the problems of calibration of special equipment as Farimometer or Colorimeter. He expressed some doubts about the accuracy of tests performed at MBS on samples submitted by Grain and Milling, showing very low reproducibility.

Traceability: Nil.

4.1.18 Survey Department (Blantyre)

The Department is authorized by Land Survey Act to perform calibration of measuring tapes. The method and facility used (an open air baseline, only one divisions are checked, only 100 m tapes are calibrated) do not ensure enough reliability. They are, however, claiming that even after establishment of measuring tapes calibration facility at MBS, they will have to approve the calibration. The problems of Electronic Distance Meters calibration were mentioned - the baseline is built with help of Kenya for this purpose. The possibility of checking the frequency of EDM's in MBS or in Zomba was discussed. The rest of survey equipment (e.g. therodolites) is adjusted by engineers from Kenya Survey Centre.

Traceability: Questionable - Kenya?

4.1.19 Geological Survey Department (Zomba)

The Department has no own calibration facilities. In the laboratory, there is typical laboratory equipment (thermometers, balances and analytical instrumentation). Field instruments are mostly gravimeters. The need of calibration of thermometers, pressure gauges, and balances was not well understood, the calibration of Gas Chromatograph s, Atomic Absorption Spectrophotometers and gravimeters was requested.

Traceability: Nil.

4.1.20 Agricultural Research Station (Bvumbwe)

This nice compound is situated amidst of experimental fields and plantations, some 25 km from Blantyre. There are three main units (laboratories) - Soil Physics, Soil Chemistry and Analytical. At the first glance, the laboratories are rather well equipped for analytical purposes (flame photometers, UV spectrophotometers, atomic Absorpotion Spectrophotometer, pH-meters etc.) The closer inspection, however, shows that many instruments are out of order, without possibility of calibration, staff not being on-the-job trained. It is a pity, that such a nice centre, with some good results in the past has so deteriorated. It could be helped, perhaps, if some experts are brought to the centre, to perform on-the-job training of the staff and the repair and calibration of instruments is assured. For industrial metrology, the calibration of analytical balances (20 pcs), thermometers (26),

pressure gauges, measuring cylinders and flasks, pH-meters could be interesting.

Traceability. Nil.

4.1.21 **University of Malawi - Chancellor College** (Zomba)
There are several departments involved with measurement activities (Department of Physics, Department of Metrology, Department of chemistry etc.). There is no similar laboratory as in Polytechnic. The education process includes information for students on the role of calibration in enhancing the validity of even the basic measurement results. The special emphasis is given to the calibration of balances and weight sets. The range of instruments comprise thermometers, aneroids, thermometers, engineering instruments (length, angle, flatness, roundness), hygrometers, balances and weights, pressure gauges, photometers, hydrometers and over 300 different electrical/ electronic measuring instruments.

Traceability: Nil.

4.1.22 **Malawi Iron and Steel Corporation (MISCOR)** (Blantyre)
The organization is a foundry producing large variety of products upon request of consumers. With exception of contraction rules and one weighing platform, no measuring instruments are used. It is surprising especially in pattern making. A generous expanding programme has been prepared with help of UNIDO. The production manager is well aware that without reliable measurements, the quality of production is doubtful. Recent claims of scrap products (e.g. brake drums) confirm the importance of temperature measurements during heat treatment. With regard to MBS, the corporation is interested in getting the MBS certification mark and will stay in contact.

4.1.23 **Precision Tool and Engineering** (Blantyre)
The programme of production if judged by the name of the company should be covered by extensive engineering measuring equipment of appropriate accuracy. However, the approach is typical: the instruments used are without any calibration and their readings "believed" to be correct ones. After recognizing the needs of calibration, the company could contribute to demands on length and engineering calibration laboratory (micrometers, calipers, vernics, force, hardness).

4.1.24 Road Traffic Department - Weighbridges Inspectors (Blantyre)

The reason for contacting this authority was to find out the links between Road Traffic department, Assize Department and perhaps Avery. However, the weighbridges Inspectors in the Department are non-existent. They were supposed to give advice as to buying, installing and putting into operation the weighbridges. For the time being, their activity is covered by W T Avery employees.

4.1.25 UNDP Office (Lilongwe)

The visit to the UNDP office was motivated by the need to know its standpoint regarding previous, present and possible future aid to MBS. As the UNDP Resident Representative was preparing for her final departure from Malawi, the mission was received by Mr Debebe Worku, Deputy Resident Representative. After explanation of the situation by the Consultant and by the Deputy General Manager, Mr Guta, Mr Worku stressed out, that the UNDP funds were overspent and there is no possibility to get another aid in the next future. Even in the case there were some funds, he explained, the UNDP will strongly object to spend them buying equipment. He suggested to explore the possibilities of bilateral or multilateral donation. Furthermore he explained that the main field of UNDP activities is concerned with providing know-how expertise. This kind of help - sending experts for on-the-job training and similar purposes will be provided by the UNDP also in future. The Consultant suggested the elaboration of the Project Document. Mr Worku stated that such a document will be considered only if presented as an official request of the Government for the UNDP aid. He pointed out that some similar requests were already presented and it would be useful but difficult to have the Calibration Centre included into the fifth country cycles. The Ministry of Trade, Industry and Tourism should present the Project as soon as possible, not later than February 1991, if it has to be considered.

2.1.26 Ministry of Trade, Industry ad Tourism (Lilongwe)

The mission was received by the Principal Secretary to the Ministry, Mr T I M Vareta. The Consultant explained main problems of industrial metrology in Malawi, stressing out the close relationship of standardization, quality control/testing/certification and metrology. The need of issuing a new, modern Law

or Metrology was expressed. The advantages of MBS and AD merger were explained. The necessity to provide funds for the laboratory premises and equipment was pointed out. The Principal Secretary being asked about the standpoint of government to the fact, that there are no calibration facilities at MBS - which is in direct conflict with MBS Act - said that not all the paragraphs of the Act were supposed to be implemented immediately. The MBS is a young organization and it needs time to grow. The suggested merger would may-be endanger the growth of MBS and shift the gravity centre to AD. The requests for funds are presented to the Ministry from many enterprises. The Consultant should make the proposal and it will be studied. If the reasons are acceptable,the Ministry will consider the possibility of allocating some funds or will approach the UNDP office for help. The Principal Secretary acknowledged the contribution of the Consultant to the development of Malawi Industry.

4.2 The Malawi Bureau of Standards

A developing nation that wishes to increase and improve its industrial capacity soon finds that measurement, standardization and quality control are essential elements of its development programme.

All governments have found it to be in the public interest to establish institutions to provide services to industry, and in some cases, to regulate industry, to assure that high quality products are produced for both domestic and international trade. Examination of such institutions around the world reveals, that each country organizes itself differently assigning various responsibilities to different institutions in both public and private sector, depending upon its own traditions and governmental philosophy.

So, following the rapid growth of industry in Malawi since independence, it was decided to establish the Malawi Bureau of Standards (MBS). Having objectives of the Bureau clearly defined in the Malawi Bureau of Standards Act (Cap.51.02) passed on December 22, 1972, the Bureau was officially opened on December 6, 1974. The activities of MBS were supposed to cover standardization, testing and calibration of precision instruments, examination and testing of commodities, control of the use of standardization marks. For the field of metrology, the Section 4 (Objects of the MBS), paragraph d, has to be quoted:

"d. to make arrangements or provide facilities for the testing and calibration of precision instruments, gauges and scientific apparatus, for the determination of their degree of accuracy by comparison with standards, approved by the Minister on the recommendation of the Board, and for the issue of certificates in regard thereto;"

With regard to this stipulation, no outputs up to now were achieved which could be considered as fulfillment of the paragraph. There are no staff members assigned for activities related to metrology.

4.2.1 Staff and Organization

At present there are 58 permanent, 10 temporary staff members, out of which 19 are working in laboratories, 6 in Quality Assurance Department, 9 in Documentation and Information Services, 5 in Standards Department. Administration Department has 17 employees. List of staff - see ANNEX VIII.

The organization chart see ANNEX IX. **It is, however, necessary to point out, that the METROLOGY DEPARTMENT is only a proposal, no such organizational unit in fact exists.**

4.2.2 Finance

The composition of MBS Income and Expenditure for the last 3 years is in ANNEX XII. The intensive growth of Testing Fees and Mark Fees is respectable.

4.2.3 PREMISES AND EQUIPMENT

The compound of MBS comprise at present three buildings, the fourth being constructed under South African and French aid. The total value of the property is MK 2 302 889. From that:

Equipment received as UNIDO/UNDP aid	MK	646 300
Buildings and other fixed assets	MK	1 213 889
Expendable equipment and materials	MK	59 889
SA and French Project	MK	382 811

NOTE: *The MBS already requested the funds for the metrology building total MK 633 000, and equipment for industrial metrology worth total MK 775 000. These requests will have to be adjusted according to the project document, if approved.*

4.2.4 Prior or on-going Assistance

The government of Malawi requested UNIDO to assist in assessing the situation and needs of standardization and related activities in 1980 ad UNIDO assigned the first Consultant under RP/MLW/80/003/A in 1981. His work resulted in the project DP/MLW/85/005: Strengthening of the Malawi Bureau of Standards. Under this project the total of 10 Consultants were fielded and some equipment provided. Two study tours and 10 fellowships were realized. The project has been practically closed with allocated budget spent. However, concerning metrology, no output has been achieved until now. The most surprising is therefore the evaluation of the respective outputs in the PPER document as "satisfactorily". The outputs were supposed to be:

2.1 Functional metrology laboratory capable of proceeding metrology services and supervision of quality control and testing activities within the MBS.

2.2 A qualified and trained specialist in metrology techniques and theory capable of running the laboratory efficiently.

2.3 Set of operational procedures (legal documents) on providing metrology supervision.

2.4 A functioning training unit capable of organizing and providing training in standardization, quality control, certification and metrology.

Activities for output 2 were suggested as follows:

2.1 Procurement, delivery, installation and putting into operation specialized measuring instruments for the metrology laboratory and ensure its proper maintenance and spare parts supply during the life of the project.

2.2 Employment of one additional national staff. Provision of specialized fellowship training and on-the-job training by international experts on basic aspects of metrological services and supervision activities of the national body in metrology.

2.3 Drafting of technical working instructions, time schedules for periodic equipment maintenance and legal documents to ensure effective running of the laboratory.

For Output 5

5.2 Fellowship training of 1 specialist in procedures and methods of training in standardization, quality control, certification and metrology.

The consultant did not find any indication of at least minimal activities to achieve these outputs and can evaluate it only as "untouched", with exception of one study tour for Principal Assizer (3 months in Sweden), and the mission of the Consultant himself.

As already mentioned, within MBS there is a parallel project under implementation, funded by South Africa and France: The establishment of a documentation and information system.

In August 1989 an expert of ARSO, Mr J O Manyala visited Malawi under project DP/RAF/07/056 "Development of Metrology Activities in the African Region".

4.2.5 **MBS Laboratories**

As mentioned, a tour through MBS testing laboratories was realized. Some of laboratories are relatively well equipped (e.g. analytical chemistry, textiles), other not so well - microbiology, paper, paints, mechanical, building materials. Surprising is that in the rather large chemical laboratory there is only one analytical balance and it is in a very bad shape, dusty, not covered, with traces of corrosion. There is no calibration facility whatsoever and no instrument has a self-calibration provision. The result is very poor reproducibility and illusory accuracy of test results. Some customers claimed low reliability of MBS tests (see 4.1.17).

In spite of fact that 19 employees are assigned to laboratory work, the laboratories do not make an impression of busy activity.

4.2.6 **Evaluation of MBS Activities**

Since 1974, when the MBS was opened, a constant growth of activities can be seen. The number of employees, as well as number of tests in a comparison with 1981 is more than double, and growing constantly. For 1990 the

number of 3540 samples to be tested could be estimated. There are 85 approved National Standards elaborated in 34 technical committees and number of draft standards. In 1989, 37 permits for production and 54 certificates were issued. Total of 699 factory inspections were realized.

However, there are some hampering factors having bad influence on over all performance of MBS. The Consultant is of opinion, that there is insufficient awareness of importance of standardization, quality control and related activities in the Ministry of Trade, Industry and Tourism. The evidence is among others the lack of its thorough treatment in the chapter on Commerce and Industry in the Statement of Development Policies (1987 - 1996). The negligence of metrology, traceability, calibration, accuracy of measurements - so typical for Malawi - is the reason why, even in MBS, no calibration facility is available. The logical result is low reliability of measurements and test results. Therefore, the earliest possible introduction of metrology and calibration is of utmost importance. The management of MBS is struggling to start metrological activities, but the barriers of disinterest by party concerned (Ministry) are too high.

The "Public relations" activities of the MBS should be improved. The good "advertisement", articles, radio transmissions, frequent seminars and workshops could help to extend the number of tests.

The MBS and AD have no information on international activities in metrology, they are not members of OIML or BIPM. This provides for an information barrier and contributes to lack of knowledge and interest in metrology.

As to staff, there are some fluctuation tendencies, characteristic for this type of organization. The MBS management is implementing the programme to stabilize the staff.

4.3 The Assize Department

Assize Department, established in 1956 is responsible for implementation of Weights and Measures Act, (Cap 48:04) issued on January 1, 1960. This Act is

"to provide for the uniformity of measures of weight, length, capacity, area and volume, the assizing and re-assizing of weighing or measuring instruments, weights and measures, better protection of the public in relation to the sake of articles and other transactions by weight or measure and for other matters incidental thereto."

In order to implement the Act, nine subsidiary regulations were issued to the practical and financial part of assize activities. It is interesting that there is no remark in the Act about Assize Department itself. According to PART II, art 10. - the Minister may appoint any person as an assizer or an inspector and issue to him an assizer's certificate. The candidates are examined by the Assize Board, established by the Minister.

The amount of work performed by AD yearly is respectable:

Balances, scales, platforms	10244 pcs assized
Weight bridges	56 pcs assized
Weights	9890 pcs assized
Capacity measures	84 pcs assized
Flow meters	712 pcs assized
Cloth meters	2120 pcs assized
Total	**23106**

The collected fees - approximately MK 50 000, per year are channelled into Government Treasury, on the other side the Government covers all the AD expenses.

4.3.1 Staff

At present, there are 42 employees in AD. Apart from Chief Assizer who is the Head of the AD and Principal Assizer, there are 23 technical employees, 7 in administration and 10 auxiliary staff. The Assize Department has three branch offices (Lilongwe, Blantyre, Mzuzu) with Head Office in Lilongwe. The Organization Chart see ANNEX X.

The total amount of staff emoluments ad benefits represent MK 172 396, yearly.

4.3.2 Finance:

As already said, the activities of AD are fully sponsored by the Government. In addition to staff expenses, there are rental costs for office in Lilongwe MK 12 000, in Mzuzu MK 6 000, and electricity and water MK 5 100, yearly.

4.3.3 Premises and Equipment

The AD owns the laboratory building in Blantyre and a residential house in Mzuzu

worth total of	MK 314 599
Equipment and cars	MK 360 000
The total value of property	MK 674 549

The list of equipment see ANNEX XI

4.3.4 Prior or On-going Assistance

There was no direct involvement of AD within the UNDP/UNIDO project activities. However, with a merger of MBS and AD foreseen, the study tour (3 months in Sweden) in Industrial Metrology for Principal Assizer Mr Mkandawire was realized in 1990.

4.3.5 Blantyre Office of Assize Division

The AD office is in the separate building in Blantyre - Chichiri, the main laboratory 20 m^2 is air conditioned. It is used for assizing of weights and cloth meters. The equipment is rather old, although kept in a good order. In other laboratories the balances and scales are assized. The attempt to develop the installation for assizing of capacity measures failed. In a separate building a prover tank (capacity 200 l) for testing of tanks, bulkflowmeters and portable flow meters is installed. The laboratory does not have a national 1 kg standard. The set of weights representing a primary standard was calibrated some 22 years ago in UK. The balances do not allow the work of the higher precision. The assizing of weighbridges is made in cooperation with W T Avery. however, the total mass of weights (20 kg each) available is only 6000 kg. The calibration of bigger weighbridges (up to 100 tones) is very doubtful. With regard to the number of weighbridges in Malawi a purchase of calibrating truck should be considered.

Traceability: According to Weights and Measures Act, the primary standards are supposed to be authenticated every 25 years un UK (which is not acceptable), local standards every 5 years and working standards every year. The best solution would then be to equip the laboratory in MBS with primary standards and assure the traceability for all the measuring equipment in malawi.

4.3.6 Evaluation of Assize Department Activities

As seen from number of assized instruments, the AD is doing a good job. However, the reliability of work with regard to overaged equipment and old authentication is not the best. An acute lack of staff is further hindrance to the amount and quality of their work. The problem is also the education and training of staff - not all applicants are able to pass complicated examinations to become an assizer. In any case, the present staff of AD would be the best nucleus for the new established metrological laboratory.

5. LEGISLATION

5.1 The Malawi Bureau of Standards Act

On December 22 1972, the Malawi Bureau of Standards Act (Cap 51:02) was issued, "to establish the Malawi Bureau of Standards and the Malawi Standards Board, to provide for the incorporation of the Malawi Standards Board as a body corporate; to vest the management and control of the Malawi Bureau of Standards in the Malawi Standards Board; to promote standardization of commodities and of the manufacture, production, processing or treatment thereof; and further to provide for matters incidental to, or connected with, the forgoing."

The Act contains six parts:

Part I: Preliminary (definition of terms used);

Part II: Malawi Bureau of Standards;

Part III: The Malawi Standards Board, its Powers, Functions, etc;

Part IV: Establishment of Standards;

Part V: Inspectors, their Appointment, Powers, etc;

Part IV: General (offences, Regulations, etc).

The objects of the Bureau are stipulated in the Part II, clause 4, for metrology being relevant the prograph (d):

> "to make arrangements or provide facilities for the testing and calibration of precision instruments, gauges and scientific apparatus, for the determination of their degree of accuracy by comparison with standards, approved by the Minister on the recommendation of the Board, and for the issue of certificates in regard thereto."

5.2 The Weights and Measures Act

On January 1, 1960 the Weights and Measures Act (Cap. 48:04) was issued "to provide for the uniformity of measures of weight, length, capacity, area and volume, the assize and re-assizing of weighing or measuring instruments, weights and measures, better protection of the public in relation to the sake of articles and other transactions by weight or measure and for other matters incidental thereto."

The Act contains following parts:

Preliminary - definition of terms used

Part I: Standard Weights and Measures;

Part II: Administration;

Part III: Assizing of Instruments, Weights and Measures;

Part IV: Sale of Articles and use of Instruments, Weights and Measures

Part V: General (Offences etc.)

The most important clause for the legal metrology activities is the clause 14. in the Part III.

"Subject to this Act, every instrument, weight and measure used in trade shall be assized or re-assized in accordance with this Act.

The subsidiary legislation to this Act is:

5.2.1 **Weights and Measures (Assize) Regulations**

It is rather precise regulation specifying the testing of Weighing Instruments (Part II), Weights (Part III), Measures (Part IV), Measuring Instruments (Part V). In the Part I, there are exemptions from the Act and technical specifications for stamps, scales, rejections marks, etc. The tables showing limits of error and sensitiveness are also provided. A very important is clause 3 (Part I) - exemptions from the Act, where we find:

a) electricity meters;
b) gas meters;
c) taxi meters;
d) water meters;
e) weighing instruments known as personal weights;
f) Measures used for the measurement of beer;
g) "Ohaus" counter steelyards.

The reasons why especially first four items are exempted are most probably technical-ones. The Assize Department have not had the necessary technical equipment. However, these instruments should be definitely assized by an official authority.

5.2.3 **Other regulations**

From the rest of 7 regulations the most important is Weights and Measures (Standards) Regulation. According to these regulations a standard is to be authenticated

by the National Physical Laboratory, U K, a local standard by the certificate issued by an assizer, similar a working standard. The limits of errors are also stated.

The periods of authentication are 25 years for Malawi Standards, 5 years for local standards and mostly 1 year for working standards. Especially the 25 years period of authentication of Malawi Standards is not acceptable.

5.3 Comments on Legislation

The valid legislation is outdated and does not correspond with the needs of industry and commerce on one side and MBS and AD on the other side. If the metrological activities are to be started and the work of AD upgraded, it is inevitable to issue the new, modern Law on Metrology. The calibration activities in Malawi will not be improved without such a law. With good organization of work of some calibration laboratories a lot of help to industry could be provided. For this purpose, the traceability within Malawi has to be established and MBS given the authority to perform the laboratories accreditation activities. By the way also in testing there are some laboratories active, without having their facilities assessed and accredited by MBS, because there is no provision for accreditation in any legislative document. The most surprising, however, is the fact, that in spite of clearly defined duties of MBS regarding calibration, during the validity of the MBS Act (Cap 51:02) which is now already 18 years, no attempt was made to realize the relevant paragraph.

The other not understandable fact is that the most important recommendations of the first expert (fielded in 1981) were left unnoticed - namely to issue the new law, to merge MBS AD and to start as soon as possible the calibration facilities. The Consultant is of opinion, that the implementation, performance and results of the project DP/MLW/85/005 would be much better especially if calibration facilities were provided.

6. FINDINGS - ANALYSIS OF EXISTING FACILITIES AND ORGANIZATIONAL STRUCTURE OF METROLOGICAL ACTIVITIES AND RELATED FIELDS

As already discussed, competitiveness of local products highly depends on their appropriate quality. To achieve this quality level, the related activities have to be operated:

- standardization;
- metrology (primary standards laboratory, legal metrology, calibration service
- quality control (testing, certification, quality assurance systems)

These elements have existed in industrilized countries since many years. They should form an interacting system. Based on technical visits and information available following analysis of the present situation regarding these elements could be made:

1. **Standardization**: There is an institution (MBS) responsible for activities in this field;

2. **Metrology**:

2.1 **Primary standards laboratory; traceability of measurements**:
There is no National Primary Standards Laboratory in Malawi. There is no consistent traceability concept in the country. Instruments used as "primary standards" (weights in AD, standards cells in MECC, Zomba, standard energy meter in ESCOM) are not satisfactorily authenticated. The establishment of National Metrological laboratory within MBS is highly recommended.

2.2 **Legal Metrology**
In spite of good job done by Assize Department, the radical renewal of the equipment, increase of employees and number of assized instruments is to be assured.

To improve the organization and over-view work, it is suggested to merge MBS ad AD, if possible MECC too.

2.3 National Calibration Service

Such a Service is non-existent in Malawi: The concept of calibration is not well known and recognized. The laboratories performing the calibration are working on their own, without proper guidance, supervision. There is no organizational structure regarding their activities.

Furthermore, some of them are in fact performing the work done in other countries by legal Metrology Authorities (ESCOM-energy meters, Water Board - water meters). Some laboratories capable of performing calibration work are practically standing aside e.g. Polytechnic. To improve the situation and in order to provide the calibration service to the industry, a National calibration Service should be organized by the MBS as soon as possible based on work of laboratories already involved in calibration.

3. Testing, certification, quality assurance systems.

The official testing laboratories are MBS laboratories. However, different other laboratories perform official testing (e.g. Agricultural Research Station - Bvumbwe) without supervision of MBS and without being officially accredited by MBS. It is recommended to establish Accreditation Body at MBS, responsible for assessment, accreditation and supervision of testing as well as calibration laboratories.

Certification is the activity performed by MBS, similarly standardization marking and permits of production.

However, there is no supervision and evaluation of Quality Assurance Systems, which are in some enterprises very sophistically established (e.g Carlsberg Brewery). The activities of MBS should be extended to this very important field.

From this analysis it is clear, that especially such components of metrology do not exist, which have or can assure the traceability of measuring equipment to measurement standards. Quality assurance systems depend very much on the existence of a National Calibration Service

supported by a National Primary Standards Laboratory with well equipped metrological laboratories.

Thus the establishment of an effective system of metrology in the country seems to be very urgent. Such a system surely would increase accuracy, uniformity and reliability in all the fields of measurements so in metrology itself as in testing and production.

7. PRINCIPLES OF WELL FUNCTIONING CALIBRATION SERVICE

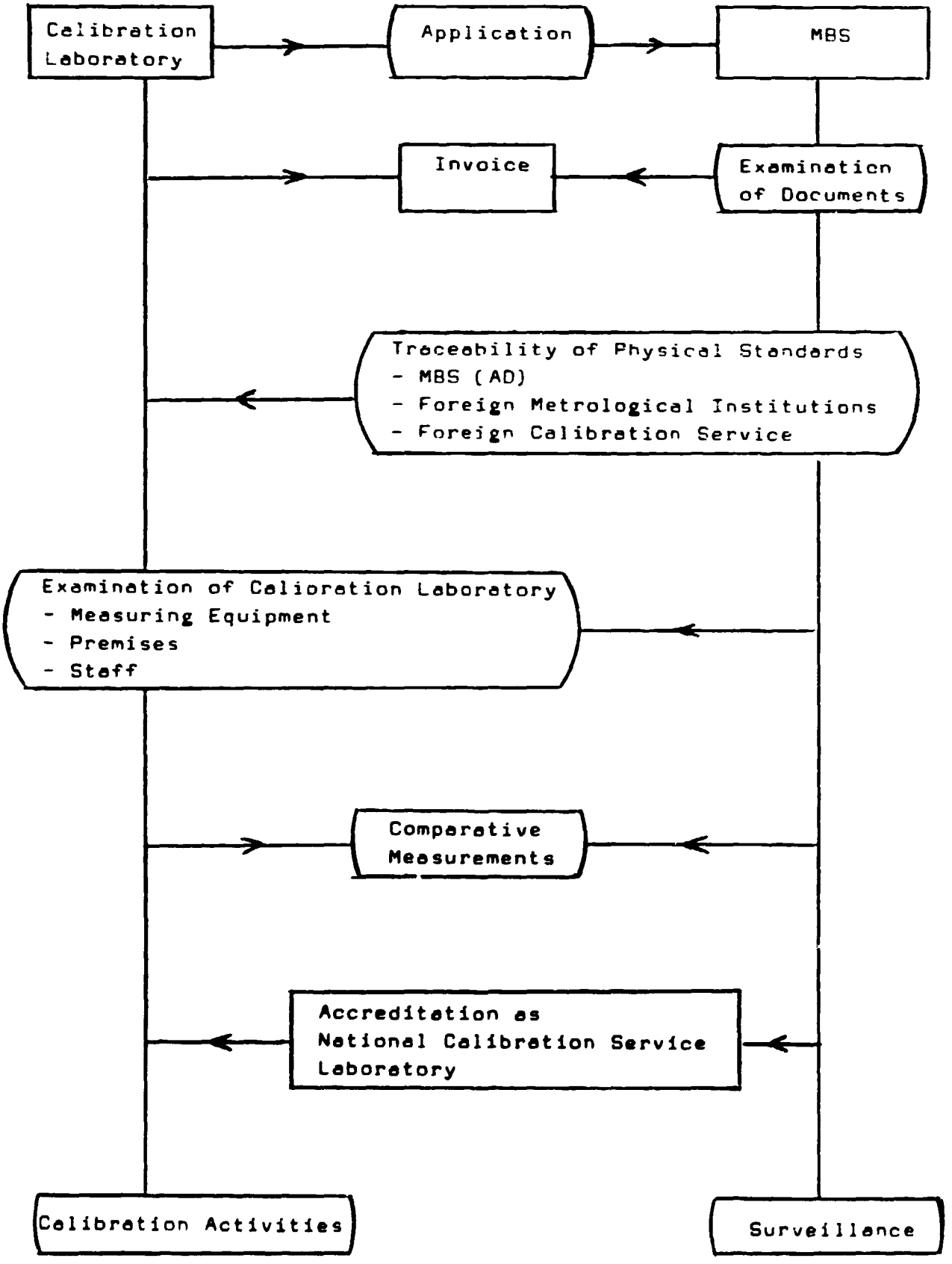
The establishment of a well functioning and up to date service network for calibration faces several problems in Malawi. The country is small and most probably only limited resources can be allocated to any public service. The consumer's protection is not well enough established, but eventually the public quest for adequate product specification will increase.

The solution should provide metrology support by having facilities for traceability and at the time make use of already existing calibration facilities. The MBS accreditation department, (Accreditation Body) should be established by an Act (preferably part of new Act on Metrology) with the main task to administer an accreditation scheme for testing and calibration laboratories. The aims of the accreditation scheme are to provide a common basis for engaging all qualified testing and calibration resources to cover the existing demands for technical testing and or calibration and to ensure that the test results are officially recognized in Malawi and in other countries. The Scheme should be voluntary and self-financed through annual fees from accredited laboratories. Assessment, surveillance and reassessment of laboratories to be carried out by teams of experts form science and industry assisted by technical educated staff of MBS. Accreditations should be time limited, normally for 3 years, with possibility of renewal. A calibration service should be established by the Act. There should be possibility to perform calibration activities by any public or private institution on a self-financed basis, provided it meets the requirements of MBS accreditation department.

The calibration laboratories will face the problem of ensuring adequate traceability for their measurement capabilities. The best solution would be the National Primary Standards laboratory. Until its establishment the assessment should carefully examine the traceability of the equipment of the laboratory and reject the application if the laboratory has no satisfactorily proved traceability.

The Flow Diagram of Accreditation Procedure on the next page is self explanatory.

FLOW DIAGRAM OF ACCREDITATION PROCEDURE



8. SUGGESTIONS FOR ESTABLISHMENT OF NATIONAL CALIBRATION SERVICE IN MALAWI

According to principles discussed in previous section, the first step is to issue the Act establishing the Accreditation Body within Malawi Bureau of Standards. The establishment of NCS may then be realized in two steps.

8.1 First Stage

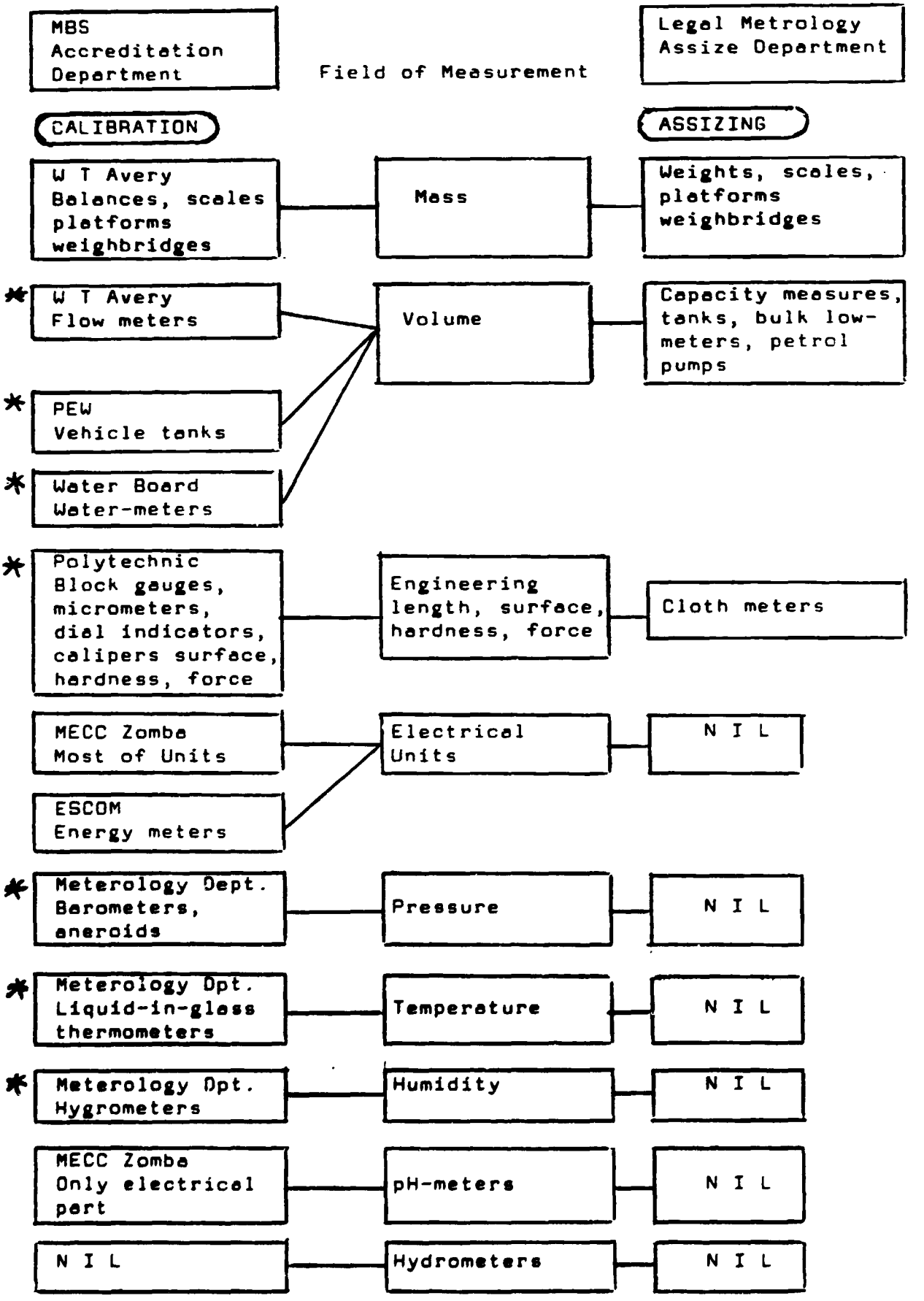
The aim is to introduce the calibration service to Malawi Industry as soon as possible, exploiting already existing facilities. The main problem of this first stage will be (as already mentioned) traceability of "working standards" in the respective laboratory. If compared with findings of technical visits, only few laboratories have more or less acceptable traceability. Therefore a maximum importance should be given to assurance, that the accreditation is issued **only when traceability is proved**. A typical example is Metrological Department at Chileka. Even having some equipment for calibration of thermometers, hygrometers and barometers, it is worthless unless traceable to the physical standards. However, the facilities of calibration (and assizing) in different fields of measurements are listed even if without traceability. The insufficient traceability is marked by "*". Traceability or acceptability of AD equipment is not up to date, it should be substantially improved as soon as possible.

The diagrams of the First Stage is on the next page.

8.2 Second Stage

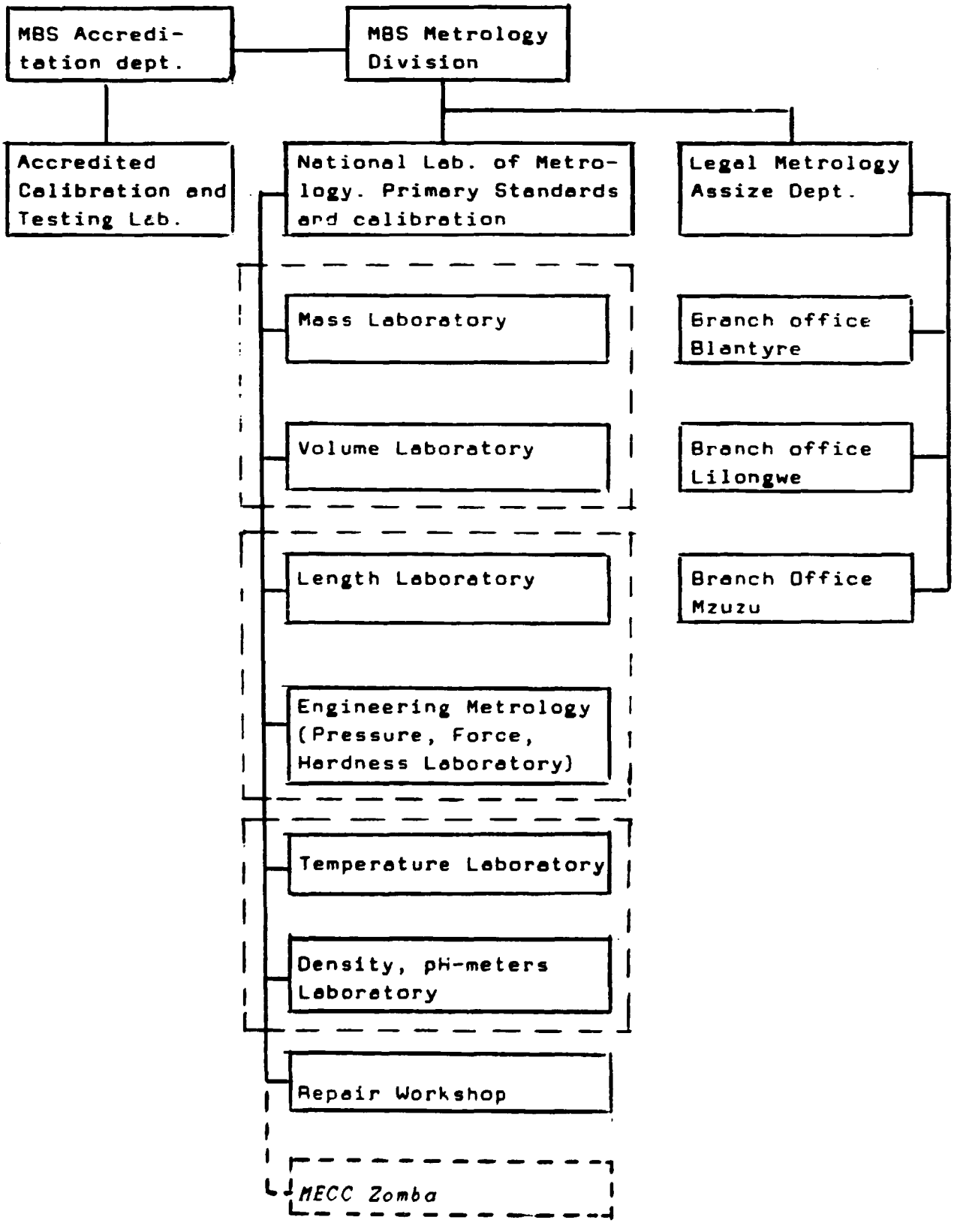
The second stage can be implemented only after construction and putting into operation the Primary Standards Laboratory (or National Laboratory of Metrology) within MBS. The laboratory will then be able to "pass on" the values of primary to secondary standards and to ensure traceability of measuring devices of all the calibration laboratories, achieving at the same time uniformity of measurements in Malawi. The accuracy of measurements of AD will be also improved. Capacity for further calibration services will be provided.

FIRST STAGE OF ESTABLISHMENT OF NCS



SECOND STAGE OF NCS ESTABLISHMENT

SUGGESTED ORGANIZATION CHART



9. SUMMARY

As the analysis of findings revealed, the situation in the field of Metrology (primary standards, legal metrology, industrial metrology) in Malawi is critical. There is insufficient legal coverage for industrial metrology activities (calibration). In spite of fact, that there is some arrangement for calibration in the MBS Act (Cap. 51:05), until now it has been completely ignored. The facilities for traceability of measurements in the country are non-existent and the reasons to have them are not understood. There is no National Calibration Service established or any attempt made until now to do so.

There is no organizational scheme for calibration service in the country. The concept of calibration is mostly not understood. The only calibration facility producing some acceptable results is Malawi Electrical Calibration and Repair Centre in Zomba. However, it has no links to MBS and there is no supervision from part of MBS or AD.

The Legal Metrology (Assize Department) is understaffed, underequipped and the traceability of so called primary standards 22 years old and therefore doubtful. The Weights and Measures Act (Cap. 48:04) is outdated and does not correspond to the needs of today's technical society. There is no Primary Standards Laboratory. It is impossible to improve this situation immediately or in a very short time. The main tasks are with Ministry of Trade, Industry and Tourism:

1. To issue the new Act on Metrology;
2. To establish the Accreditation Body within MBS;
3. To merge MBS and AD;
4. To include the Development of Metrological Activities into the next Short Term Development Plan;
5. To assign necessary funds for construction of the Metrology Laboratory Building, equipment and staff, or to find donors or sponsors;
6. To ask for further UNIDO assistance especially in the field of expertise.

The Consultant suggested the solution of the situation in two stages:

The First Stage needs only the new legislation and establishment of Accreditation Body within MBS. This Body will assess and eventually accredit and supervise the calibration laboratories as suggested on the pages 33 and 35. The staff of the Accreditation Body should be trained abroad (Denmark, Sweden). In this First Stage the traceability of mass, volume and length of AD could be accepted, the rest of quantities to be authenticated abroad. The absolute necessity of having working standards traceable (or authenticated) must be stressed out.

The Second Stage suppose the provision of a new National Metrological Laboratory, equipped with necessary primary standards, caring for the traceability within the country.

The equipment is to be installed and staff trained on-the-job by international experts. The heads of the respective laboratories shall have opportunity to study their fields of measurements in well developed countries (UK, Germany, etc). The further task of the laboratory will be to provide calibration services to industry of Malawi and, if needed, to authenticate the measuring standards for neighbouring countries (e.g. within SADCC).

ANNEX 1

REVISED:
14 NOVEMBER 1989

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
U N I D O

Project in Malawi

JOB DESCRIPTION

DP/MLW/85/005/11-04

Post title Expert in Industrial Metrology

Duration Two months

Date required October 1990

Duty station Blantyre, with travel within the country

Purpose of project To assist the Government in strengthening the Malawi Bureau of Standards to fulfill its present mandate as a standards institution.

Duties The expert will be attached to the Malawi Bureau of Standards and will specifically be expected to:

1. Analyze the existing facilities and organizational structure for industrial metrological activities within the country.

2. Identify the means and ways of initiating industrial metrological activities in the MBS.

3. Prepare the technical specifications of the physical standards (SI units) and equipment needed as well as the specifications for the facilities for maintaining these equipment.

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

Qualifications University degree or equivalent in engineering or the physical sciences with extensive experience in the organization and operation of metrological laboratories, knowledge and experience in standard measurement.

Language English

Background information With agricultural resources being predominant, the economy of Malawi is essentially based on the agricultural sector. Much of the growth of the industrial sector, which is largely agrobased, mainly occurred from 1964 to 1970, a period when most of the import substitution industries sprung up.

At present, the industrial sector covers the following industries: meat, dairy, grain mill, bakery products, edible oils, canned food, sugar malt liquors, soft drinks, cattle cake, cigarettes and pipe tobacco, cordage goods, cotton piece goods, ready made clothing, blankets, leather products, fertilizers, soaps and detergents, paints and varnishes, paper products, sport goods, pharmaceuticals, cleaning and toilet preparations, matches, UPVC pipes, furniture, sawn timber, wood products, cement, bricks, tiles and metal doors, frames and windows.

The share of the industrial sector in GDP has risen from 9.5 % in 1965 to the high projected figure of 18.9 % in 1985, while that of the agricultural sector shows quite the opposite direction since it will decrease from 57.4 % to 38.1 % in 1985. The percentage share of the industrial sector in the total domestic exports of goods will increase from 6.6 % in 1965 to the projected figure of 26.2 % in 1985.

A sector of such an increasing importance should be protected and safeguarded by providing it with adequate institutes to furnish the service infrastructure so essential for its healthy growth. Needless to say that the national standards body is one of the most important of such institutes.

As a matter of fact, the importance of standardization, as an efficient tool for industrialization, was not overlooked by the Government of Malawi. Thus, in December 1972, an Act (Cap. 51:02) was issued establishing the Malawi Bureau of Standards (MBS) as the sole statutory authority responsible for all matters related to standardization, certification, testing, quality control and calibration of instruments.

Although the MBS has been able to make good achievements within its capabilities, yet it was soon realized that it cannot play its rightful role in assisting the industrialization process since its development is far beyond that of the fast growing industrial sector. Consequently, the Government requested the assistance of a UNIDO Consultant in standardization, certification and quality control (RP/MLW/80/003) to assess the situation and to recommend the remedial measures to be taken.

The critical study conducted by the Consultant in September/October 1981 revealed clearly that, due to the meagre facilities at its disposal, the MBS is severely handicapped in its efforts to contribute substantially the economic development of the country. The study emphasized that there is a persistent need to strengthen the MBS through:

1. improving the machinery and mechanism of the elaboration of national standards;

2. expanding the testing activities of the MBS by providing facilities for the quality testing of materials and goods such as food, textiles, building materials, paper and paper products, paints and varnishes, plastics and rubber, leather and leather products and metals. The importance of such expansion is appreciated by the fact that most of the above facilities are not available elsewhere in Malawi;

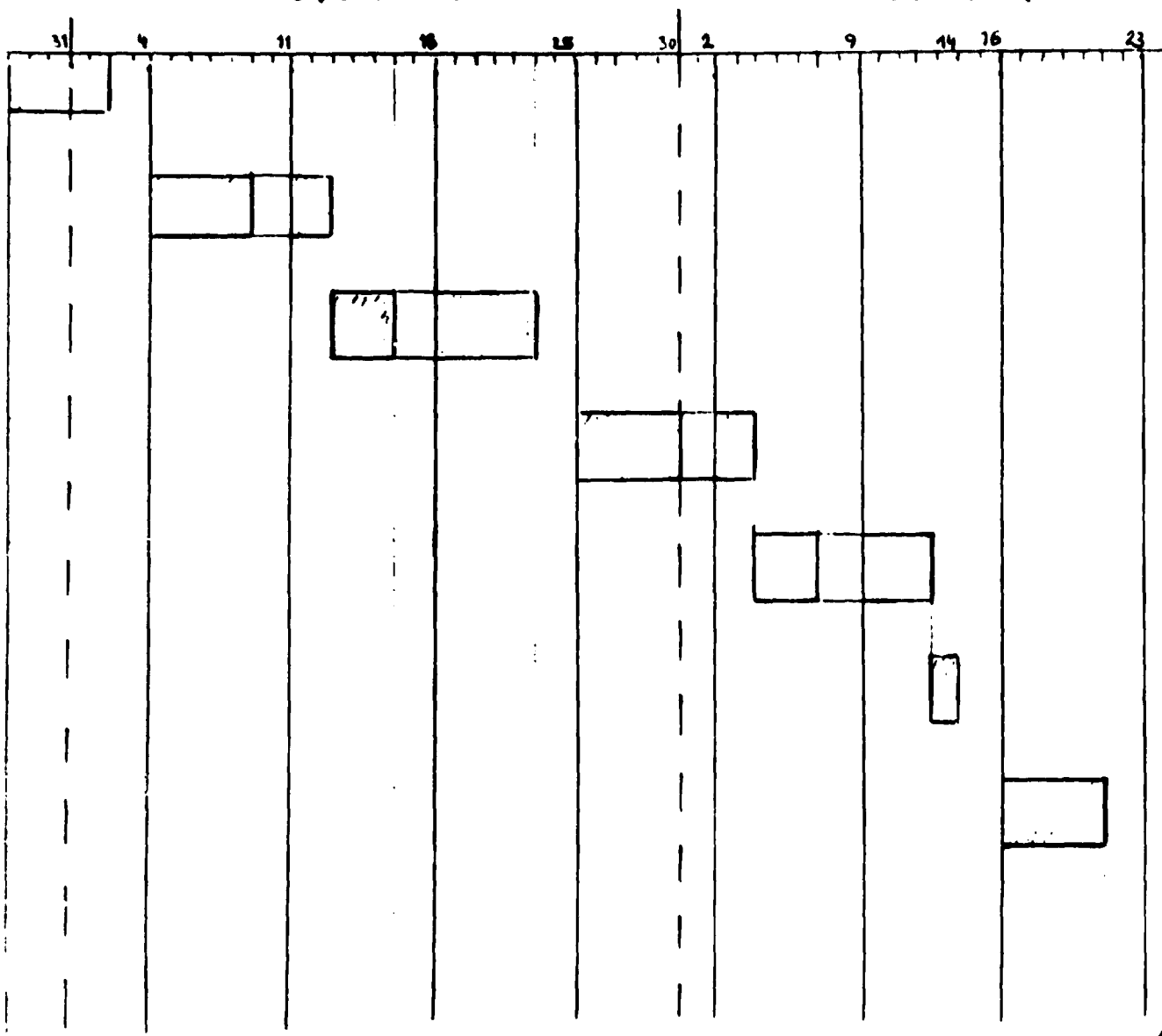
3. setting up a sound national certification marking system to eliminate the shortcomings of the rather crude scheme presently operated.;

4. initiating calibration activities. So far, there has been no metrology laboratory whereby measuring instruments could be calibrated to ensure accurate measurements so essential for industrial and control activities;

5. training the local staff of the MBS and industry to upgrade the quality of the discharge of their duties and activities in the fields of standardization, certification, testing, quality control and metrology.

It is thus anticipated that the implementation of the project will place the MBS in a position where it could play its due role in improving the national economy of Malawi.

EXPERT IN INDUSTRIAL METROLOGY - WORK PLAN



Introductory discussions, visits to MBS labs, visits to W&M labs, analysis of findings

Visits to industrial enterprises in Blantyre, PTT Calibr. lab in Zomba, discussions, assessment of calibration facilities

Evaluation of information, preparing the project proposal, advices for the metrology building construction

Preparing the Seminar on Metrology, its realization.

Finalizing the project proposal.

Typing of the project proposal, preparing and typing of Terminal Report

Debriefing at UNDP office Lilongwe

Return travel, debriefing Vienna

October 29th 1990

Prof. H. [illegible]

58

ANNEX II

ANNEX III

CO-OPERATING MBS STAFF

1.	Mr A S Khulumula	:	General Manager
2.	Mr C W Guta	:	Quality Assurance Manager
3.	Mr S J Mwalilino	:	Administration Manager
4.	Mr B W Sikoya	:	Office Manager
5.	Mr P I S Chiligo	:	Scientific Officer assigned counterpart
6.	Mr L D Taulo	:	Scientific Officer
7.	Mr M Chisi	:	Documentation Officer
8.	Mr B C Namame	:	Librarian
9.	Miss B Patel	:	Typist
10.	Mr C N Chitekwe	:	Machine Operator
11.	Mr Y Lyton	:	Messenger

MALAWI BUREAU OF STANDARDS
P O BOX 946
BLANTYRE

STRICTLY CONFIDENTIAL

QUESTIONNAIRE

ON THE STATUS AND NEEDS OF CALIBRATION SERVICES

1. GENERAL INFORMATION

1.1 Name of enterprise, Address, Tel. No:

1.2 Name of Chairman/Technical Manager:

2. INFORMATION ON TESTING, MEASUREMENTS, CALIBRATION

2.1 Technical staff concerned with testing, measurements, calibrations*

Name	Post	Qualification
a.		
b.		
c.		
d.		

2.2 Equipment available for testing, measurement, calibration*

Apparatus or Instrument	Type/Producer	Year of purchase	Type of measurement	Year and place of last calibration
a.				
b.				
c.				
d.				

2.3 Reference standards for calibration of measuring instruments used*

Apparatus or Instrument	Type/Producer	Year of purchase	Type of measurement	Year and place of last calibration
a.				
b.				
c.				
d.				

2.4 Your requests for calibration of measuring equipment*

Apparatus or Instrument	Type/Producer	Year of purchase	Type of measurement	Year and place of last calibration
a.				
b.				
c.				
d.				

2.5 Tests, measurements, calibration performed (also for customers outside)*

Apparatus or Instrument	Type/Producer	Year of purchase	Type of measurement	Year and place of last calibration
a.				
b.				
c.				
d.				

2.6 Interest of having the staff trained in:			Number of persons
Fundamental principles of metrology	Yes	No	
Calibration techniques	Yes	No	

If yes, please specify the field of measurement*

Name of person filling in this Questionnairep:

Post:

Signature and Date:

* Please, fill in the space provided, if [illegible]

ANNEX V

RESULTS OF THE NATIONAL SURVEY ON MEASUREMENTS MADE BY ASSIZE DEPARTMENT

ELECTRICAL QUANTITIES

ORGANIZATION	VOLTAGE	CURRENT	RESISTANCE
Automotive Products	4	4	4
Nzeru Radio Company	12	6	2
Optichem (Mw) Limited	2	2	2
Chitedze Agric. Research	4	4	4
Dwangwa Sugar Corporation	10	12	10
Malawi Broadcasting Corp.	14	14	14
Limbe Leaf Tobacco	4	30	-
Chancellor College	2	2	2
Euthin Sec. School	5	7	-
Tobacco Research Institute	4	4	4
Posts & Telecomm.	4	4	4
Chancellor College	148	116	70
Lilongwe Water Board	2	2	2
Salima Secondary School	10	-	-
Posts & Telecomm.	5	5	-
Nzeru Teachers College	5	5	-
Rab Processors Limited	-	-	
Lilongwe Girls Sec. School	10	15	-
Press Steel & Wire Limited	1	1	1
Zomba Sec. School	13	8	2
Phalombe Sec. School	10	10	-
Ekwendeni Sec. School	10	10	3
Nkhata Bay Sec. School	10	-	-
Thyolo Sec. School	8	8	-
Nsanje Sec. School	5	3	-
Rumphi Sec. School	5	5	-
Ubwi Sec. School	3	4	-
Mulanje Sec. School	9	8	-
Bvumbwe Agric. Research	1	-	-
Child Jesus Seminary	3	3	-
Kamuzu Academy	4	1	1
Likuni Boy's Sec. Sch.	14	16	1
Admarc Canning Co.	1	1	1
Meteorological Dept.	3	3	3
Brown & Clapperton	8	8	8
Okhai Electronics	1	1	1
Pipe Extruders	1	1	1

TEMPERATURE

ORGANIZATION	LIQUID-IN-GLASS THERMOMETERS	THERMOCOUPLES PYROMETERS	ELECTRIC. RESIST. THERMOMETERS
Automotive Products	2	-	1
Nzeru Radio Co.	6	2	1
Optichem (Mw) Limited	6	2	-
Chitedze Agric. Research	29	1	-
Dwangwa Sugar Corp.	25	12	-
Petroleum Services	-	2	-
Limbe Leaf Tobacco	3	5	4
University of Malawi	54	5	-
Euthin Sec. School	28	-	-
Tobacco Research Insti.	1	1	1
Lilongwe Water Board	3	-	-
Posts & Telecomm.	5	-	-
Nzuzu Teachers College	20	-	-
Lilongwe Girls Sec. Sch.	6	-	-
Zomba Cathoric Sec. Sch.	17	-	-
Phalombwe Sec. Sch.	10	-	-
Ekwendeni Girls Sec. Sch.	38	-	-
Nkhata Bay Sec. Sch.	16	-	-
Thyolo Sec. Sch.	10	-	-
Nsanje Sec. Sch.	13	-	-
Rumphi Sec. Sch.	10	-	-
Umbwi Sec. Sch.	17	-	-
Mulanje Sec. Sch.	87	-	-
Bvumbwe Research	28	-	-
Child Jesus Seminary	5	-	-
Likuni Boy's Sec. Sch.	8	-	-
Admarc Caning Co.	4	-	-
Controller of Roads	4	-	-
Meterological Dept.	10	-	-
Brown & Clapperton	2	-	-
Chemical Manufacturers	2	-	-
Pipe Extruders	1	1	-

ENGINEERING MEASUREMENTS

ORGANIZATION	LENGTH	ANGLES	SURFACE TEXTURE	STRAIGHTNESS	FLATNESS	ROUNDNESS
Automotive Products	2	2	-	2	-	-
Nzeru Radio Co.	18	1	1	2	1	1
Optichem (Mw) Ltd.	1	1	-	-	-	-
Chitedze Agric. Research	14	8	10	1	-	-
Petroleum Services	-	2	1	1	-	10
Euthin Sec. School	18	-	-	-	-	-
Tobacco Research Insti.	7	1	-	-	-	-
University of Mw (Zomba)	16	6	-	-	6	10
Lilongwe Water Board	2	-	-	-	-	-
Posts & Telecomm. (BT)	2	-	-	-	-	-
Nzuzu T. College	3	-	-	-	-	-
Venitian Blinds	3	-	-	-	-	-
Press Steel & Wire	7	1	-	1	2	-
Phalombe Sec. Sch.	27	-	-	-	-	-
Ekwendeni Sec. Sch.	20	4	-	-	-	-
Nkhata-Bay Sec. Sch.	9	-	-	-	-	-
Thyolo Sec. Sch.	15	-	-	-	-	-
Nsanje Sec. Sch.	12	-	-	-	-	-
Rumphi Sec. Sch.	16	-	-	-	-	-
Mulanje Sec. Sch.	39	15	-	-	-	-
Bvumbwe Agrc. Research	8	-	-	-	-	-
Admarc Canning Co.	3	1	-	1	1	-
Controller of Roads (Survey)	140	33	-	-	-	-
Okhai Electronics	1	-	-	-	-	-
Brown & Clapperton	200	6	-	10	-	10
Pipe Extruders	10	-	-	-	-	-

HUMIDITY

ORGANIZATION	HYGROMETERS
Nzeru Radio Company	2
Optichem (Mw) Limited	1
Dwangwa Sugar Corporation	1
Limbe Leaf Tobacco Company	1
University of Malawi (Zomba)	5
Tobacco Research Institute	1
Salima Secondary School	1
Phalombe Sec. School	1
Nsanje Secondary School	1
Mulanje Secondary School	3
Controller of Roads	2
Metrological Department	2

MASS

ORGANIZATION	PRECISION BALANCE
Nzeru Radio Company	8
Optichem (Malawi) Limited	2
Chitedze Agricultural Research	12
Limbe Leaf Tobacco Company	6
University of Malaiwi	23
Tobacco Research Institute	4
Lilongwe Water Board	1
Bvumbwe Research Station	20
Chemical Manufacturers	1
Pipe Extruders	7

PRESSURE AND VACUUM

ORGANIZATION	NUMBER OF INSTRUMENTS
automotive Products	6
Nzeru Radio Company	4
Chitedze Agricultural Research Station	1
Dwangwa Sugar Corporation	56
Limbe Leaf Tobacco Company	12
University of Malawi (Zombe)	5
Tobacco Research Institute	5
Bvumbwe Research Station	7
Pipe Extruders	1

PHOTOMETRY

ORGANIZATION	ELECTRIC BULBS	FLUORESCENT TUBES	FLASH LIGHT LAMPS
Nzeru Radio Company	2	-	-
Dwangwa Sugar Corporation	10	10	10
University of Malawi	3	-	-
Posts & Telecomm.	5	5	5
Bvumbwe Agri. Research	-	5	-

FORCE AND HARDNESS

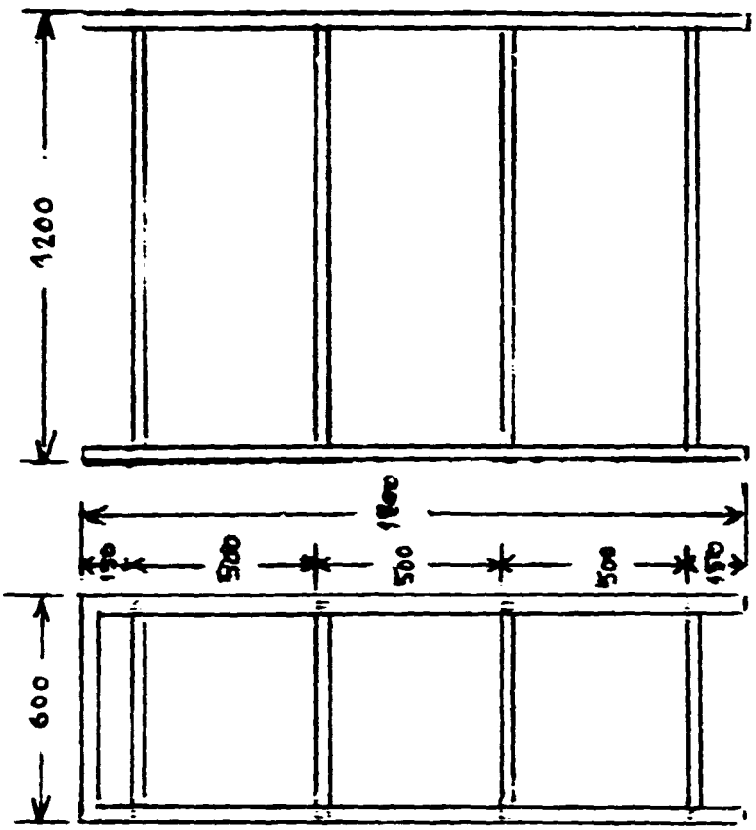
ORGANIZATION	NUMBER OF INSTRUMENTS
Nzeru Radio Company	1
Dwangwa Sugar Corporation	2
Petroleum Services	2
University of Malawi	1
Press Steel and Wire (Limbe)	1
Bvumbwe Agricutural Research Station	4

FREQUENCY AND TIME

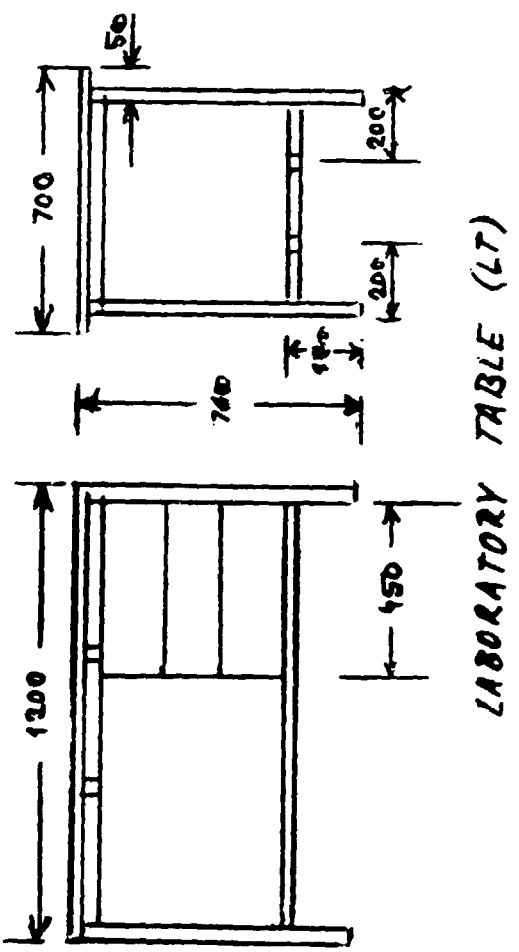
ORGANIZATION	MECHANICAL INSTRUMENTS	ELECTRONIC INSTRUMENTS
Automotive Products	1	1
Nzuru Radio Company	6	3
Dwangwe Sugar Corporation	-	2
Malawi Broadcasting Corporation	-	24
Tobacco Research Institute	2	2
Posts & Telecommunications (Bt)	-	15
University of Malawi (Zomba)	-	5
Press Steel & Wire (Limbe)	-	2
Kamuzu Academy	-	3
Controller of Roads (Survey)	-	1

DENSITY

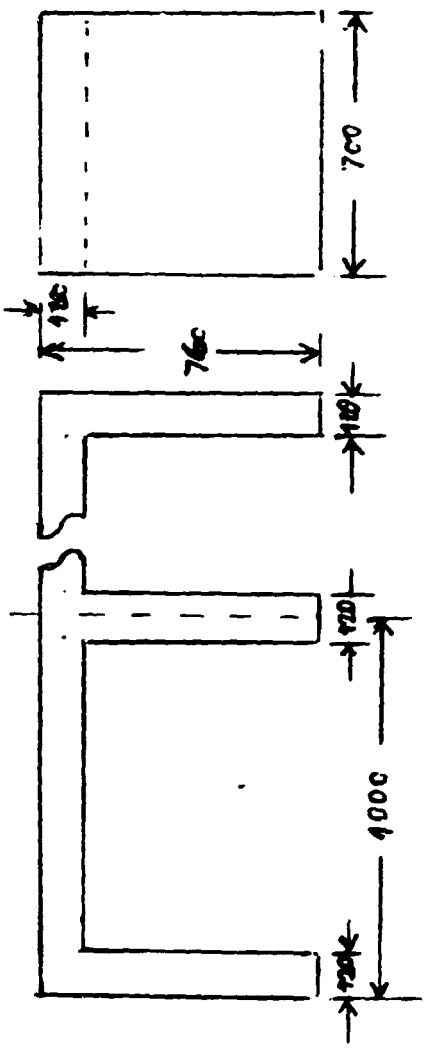
ORGANIZATION	NUMBER OF HYDROMETERS
Nzeru Radio Company	6
Chitedze Sugar Corporation	2
Dwangwe Sugar Corporation	23
Limbe Leaf Tobacco	2
University of Malawi	6
Tobacco Reseerch Institute	1
Posts and Telecommunications (Bt)	6
Zomba Catholic Secondary School	5
Phalombe Secondary School	1
Nsanje Secondary School	1
Mulanje Secondary School	2
Bvumbwe Agricultural Research Statetion	12
Child Jesus Seminary	1
Kamuzu Academy	2
Likuni Boys Secondary School	4
Meteorological Depatment	2



RACK WITH SHELVES (R)



LABORATORY TABLE (LT)



CONCRETE BENCH (C)

ANNEX VII

TECHNICAL SPECIFICATIONS

1. REQUIREMENTS ON THE METROLOGICAL LABORATORY BUILDING

The site for the building should be chosen for from intense traffic roads, heavy industry, high voltage lines. The compound of MBS or plot of AD Blantyre office are both very acceptable from this point of view. Suggested geographic orientation of the building is with offices facing North, laboratories facing South. The total surface area as suggested would be 384 m².

The building should be constructed as reinforced concrete structure with walls made of burnt bricks. The plasters and painting should prevent gathering of dust and enable easy cleaning. **The flooring** should be performed as seamless hard plastic material. Usually it is made by pouring the double composite onto the concrete base.

The laboratories shall be without windows and all of them **continuously air conditioned**. The conditioned air shall be circulated from the control unit through the double (or suspended) ceiling. Humidity control is highly recommended. The temperature is to be 20 °C, but 23 °C would be acceptable. A possibility to switch-off (or to close) individually the flow of conditioned air into respective laboratories would be welcome. The air condition in the mass and volume laboratory has to be draft-free, otherwise the weighing procedure would be impossible. For reasons of efficiency and heat dissipation, all **lighting** shall be provided by fluorescent tubes.

Electrical supply to the various laboratories should be rated largely above the current normally taken by the equipment. Each preperation room plus temperature laboratory should be equipped by three phase sockets as indicated on a drawing. The separated neutral line should be supplied to each room (three wire installation!). Each room shall have the facility of switching the power off and on separately. Each laboratory must be provided with a

separate safety earth line which under no circumstances can serve as neutral to a monophase line. For temperature laboratory and all the preperatory rooms an automatic circuits breaker for earth leakage current has to be installed. The correct grounding of the earth line should be tested during the commission of the building. The monophase sockets should withstand 16A. The adjacent laboratories should not be connected to the same phase.

2. REQUIREMENTS ON THE LABORATORIES

2.1 Repair - Workshop (Room No 9)

Activities:
Receiving incoming instruments, general check-up of instruments, repair of mechanical or electrical parts.

Installations:
Room with window, air conditioning not necessary. Electrical switchboard 220 V with two 16A monophase circuits with sockets as indicated on a drawing (Annex VI). Laboratory tables forming L-shape. Three laboratory cupboards 120 W x 50 D x 180 H (cm) with glass doors. (further mentioned as "standard type").

2.2 Store (Room No 10)

Activities:
For temporary storing the instruments to be calibrated (or after calibration), for storing of spare parts, expendables, etc.

Installations:
Room not necessary with window, without air conditioning. Against three walls install racks with open shelves combined from modules 120 W x 60 D x 180 H (cm). See the sketch in Annex VI.

2.3 Density and pH - meters Laboratory (Room No. 13)

Activities:
Calibration of hydrometers of different types, determination of density of samples upon request, calibration of pH-meters.

Installations:
Room without windows. Air conditioning for 20 °C ± 0, 5 °C. Electrical switchboard 220 V with two 16 A monophase circuits with sockets as indicated on a drawing. Laboratory tables forming L-shape. One "wet table" i.e. provided with water sink.

Three laboratory cupboards, standard type.

2.4 Preparatory Room for Density and Length (Room No. 17)

Activities:
Preparation of calibrating solutions' distillation of water, cleaning of measuring instruments, cleaning and conservation of length measuring instruments.

Installations:
Room without windows. Air conditioning for 20 °C ± 0, 5 °C. Electrical switchboard 220 V with one 16 A monophase circuit with sockets as indicated on a drawing. One 380 V - three phase socket as indicated.

One laboratory "wet table". One fume cupboard with possibility to extract vapours, 120 w x 50 D x 180 H (cm).

Two laboratory cupboards, standard type. The room serves also as the *"air lock"* for the two adjacent laboratories.

2.5 Length laboratory (Room No. 15)

Activities:
Measurements of line standards and end measures (e.g cloth measures) on a Universal Length Measuring Machine (ULM), measurement of slip gauges on vertical comparators, calibration of industrial measuring instruments (micrometers, callipers, verniers, etc).

Installations:
Room without windows. Air conditioning 20 °C ± 0,5 °C. Electrical switchboard 220 V with two 16 A monophase circuits with sockets as indicated. One concrete bench (see Annex VI) with top of polished stone, separated from the wall and one support (concrete) for ULM according to specification of producer. Two laboratory cupboards, standard type.

2.6 **Engineering - Pressure, Force, Hardness Laboratory** (Room No. 16)

Activities:
Measurements (calibration or authentication) of deadweight pressure gauges, barometers, aneroids, dill pressure gauges, force and hardness measurements.

Installations:
Room without windows. Air conditioning 20 °C ± 0,5 °C. Electrical switchboard 220 V with two 16A monophase circuits, one of them installed into the laboratory table. Sockets as indicated. Laboratory tables forming L-shape. Four laboratory cupboards, standard type.

2.7 **Tape Measurements Laboratory** (Room No 17)

Activities: Calibration of measuring tapes and other length measures.

Installations:
Room without windows. Access either from length laboratory or through one of two air locks at the ends. Air conditioning for 20 °C ± 0,5 °C. Electrical switchboard 220 V with one 16A monophase circuit with sockets over concrete installation, spaced every 2m.

A concrete bench-type installation 10 m long, 40 cm, deep, 76 cm high, at each end installed wheels supporting tensioning weights for the tapes.

2.8 **Temperature Preparatory Room.** (Room No. 19)

Activities:
Preparation of thermometers to be measured, etching of authentication marks on thermometers, preparation of thermocouples for measurements.

Installations:
Room without windows, serving at the same time as air lock for temperature laboratory. Air conditioning

for 20 °C ± 0,5 °C. Electrical switchboard with one 220 V circuit 16A and one 380 V three phase circuit. Fume cupboard as in 2.4. Water sink. Two laboratory cupboards standard type.

2.9 **Temperature Laboratory** (Room No. 20, 20a)

Activities:
Measurements on primary and secondary temperature standards. Calibration of liquid-in-glass thermometers, pletinum resistance thermometers, thermocouples.

Installations:
The laboratory consists in fact of two rooms without windows, separated by glassed partition. The lower part of partition (up to 1 m height) can be of metal frame, covered by wooden (or plywood, or formica) plates with styropore insulation inside. Two openings 10 x 10 cm (1 m and 2 m off the wall) in the height of 90 cm, with possibility of closing should be provided. In the room 20, a fume cupboard with water sink and wet laboratory table should be installed. In the room 20 a, a laboratory table and three laboratory cupboards standard type shall be installed. Both rooms are without windows. Air conditioning for 20 °C ± 0,5 °C. Electrical switchboard with three 220 V circuits 25 A and one three phase (380 V) circuit (into the fume cupboard).

2.10 **Mass Laboratory** (Room No 21)

Activities:
Calibration of secondary standard weights to national reference standards. Verification of precision weights.

Installations:
Room without windows. Air conditioning for 20 °C ± 0,5 °C. Electrical switchboard 220 V with two 16 A monophase circuits with sockets as indicated. Along one wall a concrete bench with top of polished stone should be installed. It should be separated from the wall (not attached to). One support for the 20 kg balance (a concrete piller) 120 w x 60 D x 76 H (cm) with top of polished stone. Two laboratory cupboards, standard type.

2.11 Calibration and Pattern Approval of Balances (Room No. 22)

Activities:
Calibration and examination for pattern approval of weighing instruments (OIML class II, III, IV) up to capacity of 30 kg. Temporary training of metrology inspectors.

Installations:
Room without windows. Air conditioning for 20 °C ± 0,5 °C. Electrical switchboard 220 V with two 16 A monophase circuits with sockets as indicated. L-shaped concrete bench as on a drawing (Annex VI), separated from the wall, with top of polished stone. Two laboratory cupboards, standard type.

2.12 Preparatory Room for Mass and Volume Laboratory (Room No. 23)

Activities:
Cleaning of weights, weighing instruments and volume (capacity) measures. Preparation of distilled water.

Installation:
Room without windows. Air conditioning for 20 °C ± 0,5 °C. Room serves as an airlock for mass and volume laboratories. Electrical switchboard 220 V with one 16 A monophase circuit and one 380 V three phase socket in the fume cupboard. One laboratory *"wet table"*. One fume cupboard as in 2.4. Two laboratory cupboards, standard type.

2.13 Volume Laboratory (Room No. 24)

Activities:
Calibration of secondary standard volume measures and volume glassware up to 20 l.

Installations:
Room without windows. Air conditioning for 20 °C ± 0,5 °C. Electrical switchboard 220 V with one 16 A monophase circuit. L-shaped concrete bench as on a drawing (Annex VI), separated from the wall, with top of polished stone. Three laboratory cupboards, standard type.

3. PHYSICAL STANDARDS AND EQUIPMENT

As mentioned before, the main problems in Malawi are non-existent facilities on the level of primary standards and insufficient facilities on the level of secondary standards. The metrological activities of AD are confined to three quantities, mass, volume, length, however, the equipment used is not the best one and traceability doubtful. Based on the findings from technical visits, the Consultant suggests to equip these three fields of measurement anew, with updated instruments, simultaneously to provide a National Primary Standard of Mass 1 kg weight, to be authenticated at BIPM, Paris. The field of measurement of length is to be extended from end measures to slip gauges, line standards and tape measures calibration. The Volume laboratory should be reequipped by capacity standards and balances for gravimetric calibration of capacity measures. As completely new quantities to be introduced are pressure, force, hardness, temperature, density, pH-metry. Some of these quantities may not be of utmost importance for the present time, but in few years there will be a strong demand for measurements in these fields. And when equipping this kind of organization, an advanced view should be used.

3.1 Equipment for Mass Laboratory

3.1.1 One National Primary mass Standard - 1 kg weight of non-magnetic stainless steel, adjustment tolerances 1 mg, on basis of conventional density of 8 000 kg.m^{-3}. Certified at BIPM.

3.1.2 One Primary Set of Mass Standards - in accordance with OIML R120, class E from 1 mg to 2 x 10 kg.

3.1.3 One secondary Set of Mass Standards as per item 3.1.2, but marked so as to avoid confusions.

3.1.4 One set of Verification Weights (for verification of analytical, drugs and jewellery balances) - in accordance with OIML Class E_2, from 10 mg to 100 g in stainless steel.

3.1.5 One set of weights, according OIML Class F, from 10 mg to 2 x 2 kg.

3.1.6 One set of weights, according OIML Class F_1, one 5 kg weight, 2x10 kg.

3.1.7 capacity 20 kg, repeatability 5 mg

3.1.8 One Calibration Balance, capacity 2 kg, repeatability 0,1 mg.

3.1.9 One Calibration Balance, (analytical type), capacity 200 g, repeatability 0,01 mg.

3.1.10 One Calibration Balance, (analytical microbalance type), capacity 20 g, repeatability 0,001 mg.

3.2 **Equipment for Length Laboratory**

3.2.1 One National Reference Set of gauge blocks, according to OIML RI 30, class AA, from 1 to 100 mm, comprising 111 (or 121) blocks with calibration certificates from national metrology service (NMS) for the blocks of 10, 20, 25, 50, 75 and 100 mm.

3.2.2 One National Reference Set of gauge blocks, according to OIML RI 30, class AA, comprising blocks of 200, 300, 400 and 500 mm, all with calibration certificates from NMS.

3.2.3 One Secondary Reference Set of gauge blocks, OIML class A, composition as item 3.2.1, marked so as to avoid confusion.

3.2.4 One Secondary Reference Set of gauge blocks, OIML class A, composition as item 3.2.2, marked so as to avoid confusion.

3.2.5 Two Vertical Comparators for gauge blocks (one for blocks up to 100 mm, one for 300 mm), resolution 0,1 um or less.

3.2.6 One horizontal Universal Length Measuring Machine for measurements on end gauge blocks and line standards up to 1 m, with accuracy better than 5 um.

3.2.7 One National Reference Line Standard, length 1000 mm (H formed section), divided in mm. To be used with item 3.2.6 and sometimes being the delivered part of the same.

3.2.8 Three Measuring Tapes of stainless steel, total length 10 m, divided in cm, to be used with a tension of 50 N, with certificates for every dm from NMS.

3.2.9 Auxiliary equipment as e.g. devices for inspection of the degree of flatness of gauge blocks, metric steel rulers, magnifying glasses, optical profile projector, toolroom microscope with accessories, kit for cleaning and maintenance of gauge blocks, etc.

3.3 Equipment for Volume Laboratory

3.3.1 One Set of Volumetric Flasks with graduated neck, according to OIML RI 43, adjusted at 20 °C in *"delivered"* capacity, set of 0,1-0,2-0,5-1-2-5-10 l.

3.3.2 One installation including automatic burettes in glass, fixed-volume overfill system, supplied by reservoir (100 l or more) with distilled water, including measures adjusted to 0,01 % in *"delivered"* capacity, set of 1-2-5-10 l.

3.3.3 Set of glass pipettes according to OIML RI 41, from 1 to 100 ml.

3.3.4 Set of Measuring flasks in glass, according to OIML RI 43, from 0,1 to 10 l.

3.3.5 Set of Volumetric Verification Measures in stainless steel, capacities 5-10-20 l.

3.3.6 Precision Balances - one 30 kg capacity
- one 2 kg capacity

3.4 Equipment Engineering Measurements

3.4.1 Pressure

3.4.1.1 One Standard Mano-Barometer for connection to external test chamber, accuracy ± 5 Pa, range 0 to 110 kPa. Two-position reading on precision scale of upper and lower mercury level to ± 0,05 mm. Inner diameter of tube at least 11 mm, certified by officiel institute.

3.4.1.2 One Secondary Standard Barometer, accuracy ± 20 Pa, suitable for connection to test chamber, range 2,5 to 120 kPa.

3.4.1.3 One Rotating Piston Dead-weight pressure gauge calibrator (for oil), accuracy ± 0,05 %, consisting of two single piston testers with ranges 0,1 to 6 MPa and 1 to 60 MPa.

3.4.1.4 Two sets of Secondary Test Gauges, accuracy 0,25 %, dial diameter 150 mm, consisting of
0-400 kPa for use on air
0-1 MPa for use on air
0-2,5 MPa for use on oil
0-6 MPa for use on oil
0-10 MPa for use on oil
0-60 MPa for use on oil

3.4.1.5 Oil to water separator, range of use to 40 MPa.

3.4.1.6 Barometer Test Chamber for connection to item 3.4.1.1, comprising chamber for installation of mercury barometers and horizontal and vertical aneroid type precision barometers.

3.4.2 **Force**

3.4.2.1 One set of Reference Dynamometers (load cells) made from specially aged steel. Resolution at least 0,01 % of the range, warranted 2 years stability of calibration with certificates from NMS. Ranges 52050-100-200-600 kN.

3.4.3 **Hardness**

3.4.3.1 Brinell and Vickers Hardness Testing Machine.

3.4.3.2 Rockwell Hardness Testing Machine.

3.4.3.3 Three Sets of Hardness Standards for each with certificates of NMS.

3.5 **Equipment for Temperature Laboratory**

3.5. Triple Point Cell (3 pieces) containing water of isotopic content as specified for realizing this temperature fixed point of 0,01 °C with precision of 0,2 mK or better.

3.5.2 Two Sets of Precision Type laboratory mercury-in-glass thermometers, total immersion type, with auxiliary scale at 0 °C, for range 0 - 100 °C, divided in 0,02 °C.

3.5.3 Two sets of Precision Type Laboratory mercury-in-glass thermometers, total immersion type, for range 0 - 360 °C, divided in 0,1 °C.

3.5.4 Two speciel baths for calibration of thermometers. One is a water bath for range 0 - 100 °C, the other is oil bath for range 50 to 250 °C. Temperature stability and uniformity better than 0,005 °C for water bath and 0,05 °C for oil bath. An additional *"flow-through"* cooler is needed for the water bath.

3.5.5 Ice point bath for calibration of thermometers, immersion depth minimum 300 mm.

The above mentioned equipment is the basic one. For advanced temperature measurements, the equipment for calibration of platinum-resistance thermometers and thermocouples has to be provided as follows:

3.5.6 Primary Resistance Thermometer (3 pieces), platinum wound in protective atmosphere, ice resistance 100 ohms, length of quartz tube at least 400 mm. To be supplied with calibration table from NMS, for fixed points of oxygen, triple point of water and freezing points of tin and zinc.

3.5.7 High accuracy AC automatic resistance bridge for measurements with four-terminal primary platinum resistance thermometers.

3.5.8 Pneumatic sand bath for calibrations in the range 100 to 800 °C. Temperature regulation and stability better than 0,1 °C at 500 °C.

3.5.9 Primary platinum-10 %rhodium platinum thermocouples (3 pieces) to be supplied with certificates from NMS.

3.5.10 Secondary platinum-10 %rhodium platinum thermocouples (2 pieces) to be supplied with certificates from NMS.

3.5.11 Digital Voltmeter for accurate thermo-voltage calibration, 6 digits, with low-thermal binding posts and externally adjustable zero. Highest resolution at least 1 mV (or better), 6 months stability 0,005 %, lowest range 0,01 V, highest 100 V.

3.5.12 Themocouple Comparison Furnace with temperature stability 1 °C or better, range up to 1400 °C.

3.5.13 Auxiliary items as e.g. tubing for thermocouples, thermocouple switches, thermocouple wire etc.

3.6 Equipment for Density and pH-laboratory

3.6.1 Two sets of National Reference Standards consisting of first grade laboratory Standard hydrometers, covering range 600 to 2000 kg m^{-3}, range of each 20 kg.m^{-3} divided in 0,2 kg.m^{-3}.

3.6.2 Two sets of General Purpose Hydrometers for the same range, but divided in 0,5 kg.m^{-3}.

3.6.3 Two sets of Standard saccharimeters.

3.6.4 Two sets of Standard Alcoholmeters, scale in volume %, divided in 0,1 % vol.

3.6.5 Analytical Balance, capacity 200 g, repeatability 0,1 mg

3.6.6 Standard pH-meter, with calibration of NMS.

3.6.7 Set of different electrodes.

3.6.8 Set of Reference Buffer Solutions with certificates.

3.6.9 Digital Voltmeter as item 3.5.11.

3.6.10 Auxiliary equipment comprising laboratory glassware, thermometers, glass measuring cylinders, thermostat etc.

3.7 Electrical Units

As mentioned, the electrical units calibrations are performed in MECC Zomba. The Consultant did not want to interfere with technical policy of Post and Telecommunications, but here are some suggestions as to equipment improvement.

3.7.1 Potentiometer facility (for absolute DC-voltage calibration) consisting of six-dial guarded potentiometer, null detector sensitive to 0,01 mV and stabilized current supply.

3.7.2 Precision Voltage supply (voltage calibrator), six decade type with ranges 0-1100 V, 0-110 V, 0-1 V, output current minimum 50 mA on 110 to 1100 V, accuracy and stability of output better than 0,002 %.

3.7.3 Digital Voltmeter for accurate measurements (DC, 5 full digits).

3.7.4 Secondary Standard Energy Meter (Class 0,2 or better) for traceability of ESCOM Standards.

3.7.5 Cesium 133 atomic primary frequency standard. Accuracy 2 x 10^{-12}. Complete with degausses, clock display ad standby power supply.

3.7.6 Rubidium - vapour stabilized clock (transportable), stability 1 x 10^{-10} or better.

If the MECC is attached to MBS, some other ideas may come out. It is also possible, that some of suggested devices were already ordered or are in the process of requisitioning.

3.8 General

When equipping such a metrology centre, a lot of auxiliary equipment must be available, starting from equipment for repair workshop (handtools, small precision lathe, drilling-boring machine, multimeter, soldering facility etc.), to thermometers needed in each laboratory (at least 20 thermometers range 18 to 24 °C divided in 0,01 °C, another 20 thermometers for range 0 to 50 °C divided in 0,1 °C), laboratory glassware, chemicals etc, representing not small amount of financial means.

4. Financial Considerations

With regard to overall inflation tendencies, it is impossible to give a precise estimate of funds needed to equip the laboratories. The Consultant will therefore give only rough estimate of total costs of equipment in the laboratories as follows:

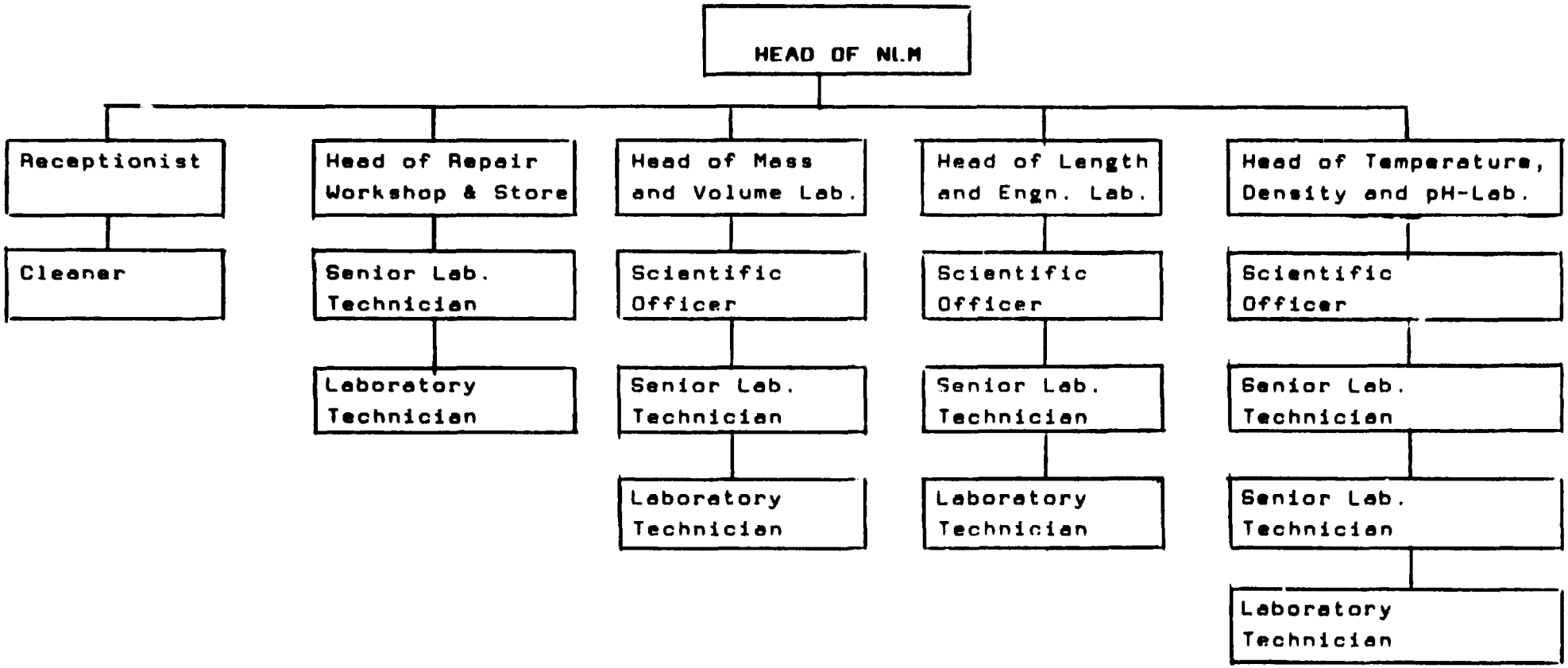
4.1	Mass laboratory	US Dollars	40 000
4.2	Length laboratory	"	85 000
4.3	Volume laboratory	"	30 000
4.4	Engineering Measurements		
4.4.1	Pressure	"	47 000
4.4.2	Force		30 000
4.4.3	Hardness		19 000
4.5	Temperature basic		35 000
4.5.1	Temperature advanced		61 000
4.6	Density		29 000
4.6.1	pH-laboratory		21 000
4.7	General		12 000
	TOTAL MBS		**410 000**
4.8	Electrical Units MECC		113 000

5. ORGANIZATION AND STAFF OF NATIONAL LABORATORY OF METROLOGY

The staff of NLM must be well trained on-the-job, responsible and skilled. It is necessary to have sufficient staff available not only for the final status, but also for the project implementation. The exposure of staff members to expertise given from UNIDO is very important, similar to fellowships in well established institutions abroad.

It is suggested to implement organization scheme with minimum of 19 employees as on the next page.

SUGGESTED ORGANIZATION CHART OF NLM



ANNEX VIII

MALAWI BUREAU OF STANDARDS

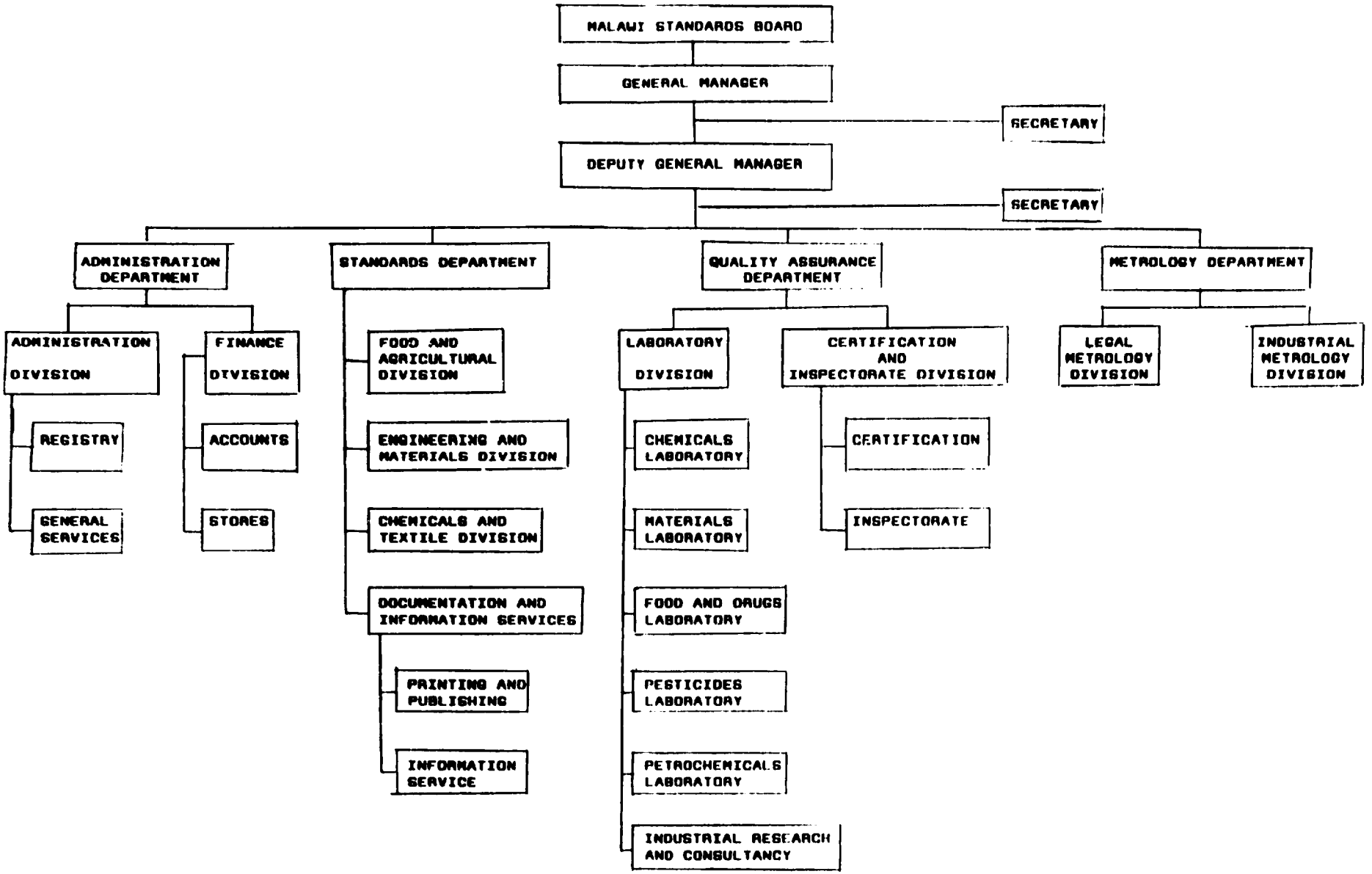
STAFF LIST AS AT 1 APRIL 1990

NO.	NAME	DESIGNATION
1.	A S Khulumula	General Manager
2.	Mrs E Gondwe	Secretary
	ADMINISTRATION DEPARTMENT	
3.	S J Mwalilino	Administration Manager
4.	Mrs M T Zintambila	Secretary
	Administration Division	
5.	C W Pindani	Administration Officer
6.	B W Sikoya	Office Manager
7.	M A E S Kausiwa	Clerical Officer
8.	J Thowela	PABX Operator
9.	Y Lyton	Messenger
10.	A L Siliya	Messenger
11.	L Baleka	Watchman
12.	T Cholera	Cleaner
13.	G Phiri	Cleaner
14.	L Gunda	Cleaner
	Finance Division	
15.	L C Mkandawire	Senior Accountant
16.	S B Kasonde	Assistant Accountant
17.	H N Makwinja	Clerical Officer
18.	Miss T Moyo	Accounts Assistant
19.	F R Z Kansichi	Accounts Assistant
	STANDARDS DEPARTMENT	
	Food and Agriculture Division	
20.	H E Gaga	Senior Standards Officer
21.	Miss R M Chikufenji	Standards Officer
22.	Miss B Patel	Typist
	Engineering and Materials Division	
23.	L Mwakoyoka	Standards Officer

NO.	NAME	DESIGNATION
	Chemicals and Textiles	
24.	E B Kamangira	Standards Officer
	Documentation and Information Services	
25.	M A Chisi	Documentation Officer
26	A L Palika	Assistant Editor
27.	B C Namame	Assistant Information Officer
28.	L Machirika	Computer Technician
29.	C J Chitekwe	Printer Operator
30.	Mrs J Mwenelupembe	Typist/Computer Operator
31.	Miss J Kapakase	Computer Operator
32.	G P Senzanimanja	Library Assistant
33.	A N Hiwa	Micrographic Operator
	QUALITY ASSURANCE DEPARTMENT	
34.	C W Guta	Quality Assurance Manager
35.	Mrs E G Maseya	Secretary
	Certification and Inspectorate Division	
36.	C Malata Chirwa	Certification Manager
37.	H G Myhaniwa	Scientific Officer
38.	M G D Nhlema	Senior Laboratory Technician
39.	P L K Kondowe	Laboratory Technician
	Laboratory Division	
	Materials Laboratory	
40.	P I S Chiligo	Scientific Officer
41.	D Muse	Senior Laboratory Assistant
	Chemistry Laboratory	
42.	L D Taulo	Scientific Officer
43.	D M D Chokazinga	Scientific Officer
44.	L Nkhoma	Laboratory Technician
45.	W T C Chisale	Laboratory Technician
46.	G Newiri	Laboratory Assistant
47.	G D Segula	Laboratory Assistant
48.	J E J Mchakulu	Laboratory Assistant
49.	A G L Mbewe	Laboratory Attendant

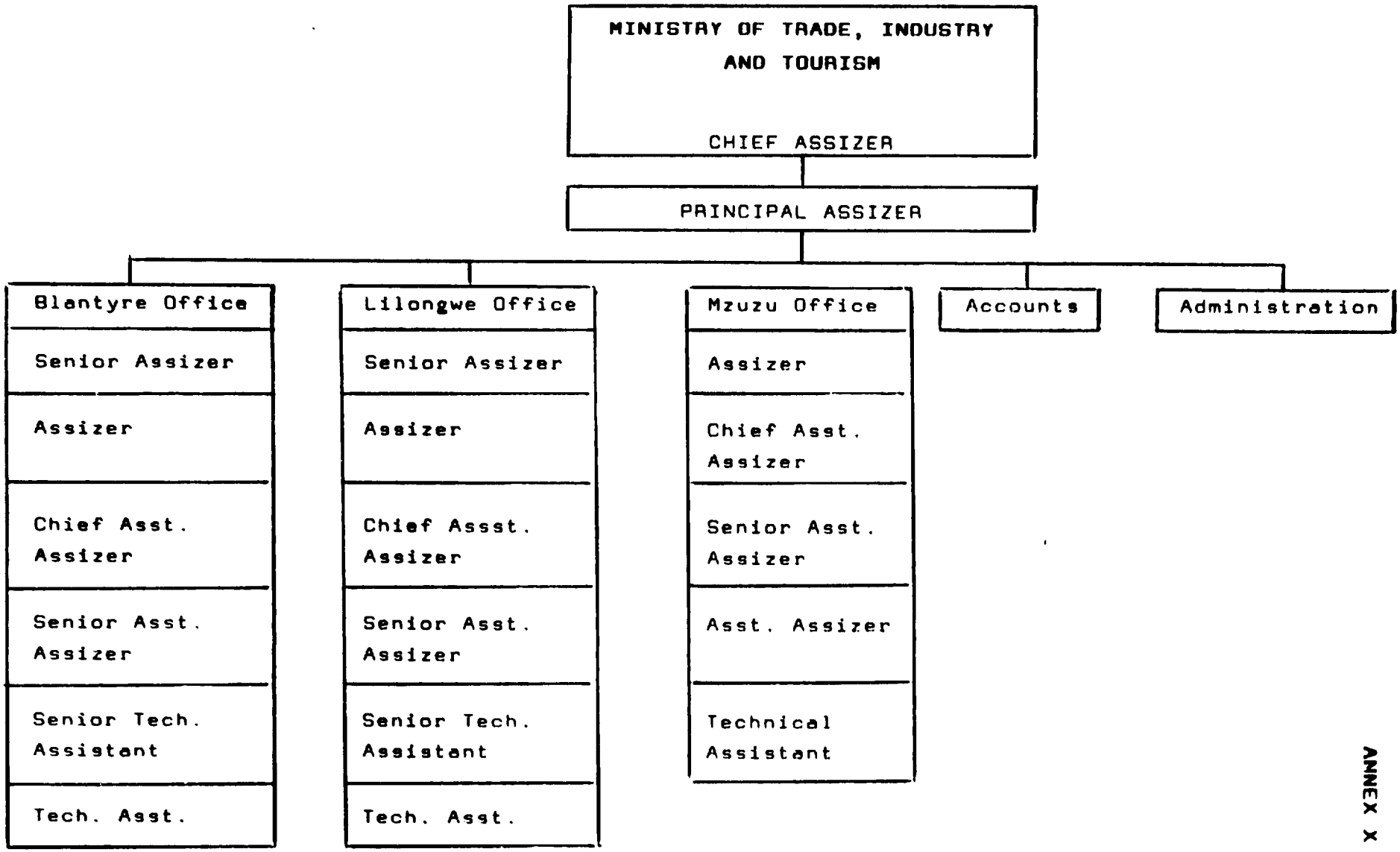
NO.	NAME	DESIGNATION
	Pesticides Laboratory	
50.	E G Chinangwa	Assistant Laboratory Manager
51.	H N Mzima	Laboratory Technician
52.	J W Chitekwe	Senior Laboratory Attendant
	Petrochemicals Laboratory	
53.	M V Nyathi	Senior Laboratory Technician
54.	W Kafoteka	Laboratory Assistant
	Pharmaceuticals Laboratory	
55.	S G Kumwenda	Laboratory Assistant
	Microbiology Laboratory	
56.	D G Chalunda	Assistant Laboratory Manager
57.	S S E Kanyanda	Laboratory Technician
58.	L A B Mwithwa	Laboratory Assistant
	TEMPORATY EMPLOYMENT	
59.	Miss H Banda	Typist
60.	Miss F Makonyola	Typist
61.	Miss V Kuntonya	Micrographic Operator
62.	Miss S Kaluwayo	Clerical Officer
63.	A A Makumba	Driver
64.	J B Kadangwe	Driver
65.	G S Mtambo	Driver
66.	L Supriano	Labour
67.	D Yasin	Labour
68.	L S Mbewe	Labour

MALAWI BUREAU OF STANDARDS



ANNEX IX

ASSIZE DEPARTMENT ORGANIZATION CHART



ANNEX X

ANNEX XI

ASSIZE DEPARTMENT

LIST OF PRESENT EQUIPMENT

1. MASS

1.1 Malawi Standards

1 set of weights 20 kg - 1 mg

1.2 Local Standards

1 set of weights 20 kg - 1 mg

1.3 Working Standards

2 sets of weights 20 kg - 1 mg

5 sets of weights 2 kg - 1 mg

2. LENGTH

2.1 Malawi Standards

1 Standard Meter Comparator

2.2 Local Standard

1 Standard Meter Comparator

2.3 Working Standards

1 Standard Meter/Yard Comparator

2 Line Standards 1 m (flat type)

2 Measuring Tapes 50 m

3. VOLUME

3.1 No Malawi Standard

3.2 Local Standard

1 set automatic pipettes 10 l - 25 ml

3.3 Working Standard

1 set of capacity measures 20 l - 250 ml

4. TESTING EQUIPMENT

4.1 Precision Balances

1 Precision Balance - 25 kg capacity, 15 mg sensitivity
1 Precision Balance - 10 kg capacity, 6 mg sensitivity
1 Precision Balance - 5 kg capacity, 4 mg sensitivity
1 Precision Balance - 1 kg capacity, 2 mg sensitivity

4.2 Beam Scales

1 Beam Scale 25 kg capacity
3 Beam Scales 5 kg capacity
1 Beam Scale 2 kg capacity
4 Electronic top pan balances
2 Counter Scales

4.3 Weights for Weighbridges Testing

300 Test Weights 20 kg each

4.4 Capacity Measures

2 Proving Tanks, capacity 200 l
1 Proving Tank, capacity 20 l
2 Capacity Measures, 20 l
2 Capacity Measures, 10 l
1 Capacity Measure, 5 l
1 Capacity Measure, 500 ml
2 Capacity Measures, 35 ml
1 Set of pipettes
1 Set of Displacement Plungers

4.5 Old (imperial) Balances

1 Precision Balance, 50 lb capacity
1 Precision Balance 1 lb capacity
1 Precision Balance 1 oz capacity.

ANNEX XII

MALAWI BUREAU OF STANDARDS

OPERATING ACCOUNT FOR THE YEAR ENDING 31 MARCH

INCOME	1988	1989	1990
Malawi Governme.. Grant	329 168	571 140	699 054
Testing Fees	112 949	146 197	205 278
Mark Fees	90 969	158 489	212 119
Members subscriptions	3 200	3 295	-
Miscellaneous receipts	1 667	1 000	3 129
Interest receivable	2 036	7 505	8 669
Sale of publications	684	1 639	493
Quality Development Cess	8 087	59 371	77 796
Profit/(Loss) on disposal of fixed assets	-	(203)	484
	548 760	948 433	1 207 022
EXPENDITURE			
Staff emoluments and benefits	292 858	372 201	552 497
Depreciation	138 297	142 035	255 884
Subscriptions	32 745	40 578	42 121
Motor vehicle running expenses	32 556	46 132	77 271
Printing and stationery	26 581	50 038	50 602
Laboratory chemicals and glassware	18 802	64 884	85 376
Postage and telephones	21 481	24 960	21 718
Repairs and maintenance	28 842	79 332	76 087
Electricity and water	8 594	11 810	14 143
External travelling	8 253	10 353	11 552
Conference and seminars	452	460	664
Cash loss	4 826	1 945	-
Auditors' remuneration			
- fees - current year	5 000	8 500	12 000
- prior year	-	1 500	1 500
- other professional fees			
- current year	2 000	5 000	8 000
- prior year	1 000	6 500	3 000
- expenses	225	318	773
Stores and cleaning materials	3 772	4 105	6 832
Books and journals	404	5 088	1 208
Entertainment	3 072	10 534	6 266
Bad and doubtful debts	2 598	1,701	207
Insurance	2 776	6 460	9 736
Office rent	2 520	1 680	2 940
City rates	2 774	1 607	4 847
Legal and professional fees	2 309	910	-
General expenses	622	1 482	2 074
Bank charges	1 133	1	1 904
	644 492	[illegible]	1 254 202
(DEFICIT)/SURPLUS ON OPERATIONS FOR THE YEAR (Note 4)	K (95 732)	K 46 389	K (47 180)

ANNEX XIII

TECHNICAL VISITS

1. W T Avery
2. Malawi Electricity Calibration and Repair Centre
3. Electricity Supply Commission of Malawi
4. Blantyre Water Board
5. University of Malawi - Polytechnic
6. Meteorological Department
7. Air Malawi
8. Carlsberg Malawi Brewery
9. SUCOMA
10. Mobil Oil
11. Plumbing and Engineering Works
12. Petroleum Services Company
13. General Tinsmiths
14. David Whitehead and Sons
15. Portland Cement
16. Industrial Gasses
17. Grain and Milling Company
18. Survey Department
19. Geological Survey Department
20. Agricultural Research Station
21. University of Malawi - Chancellor College
22. Malawi Iron and Steel Corporation
23. Precision Tool and Engineering
24. Road Traffic Department
25. UNDP Office
26. Ministry of Trade, Industry and Tourism

ANNEX XIV

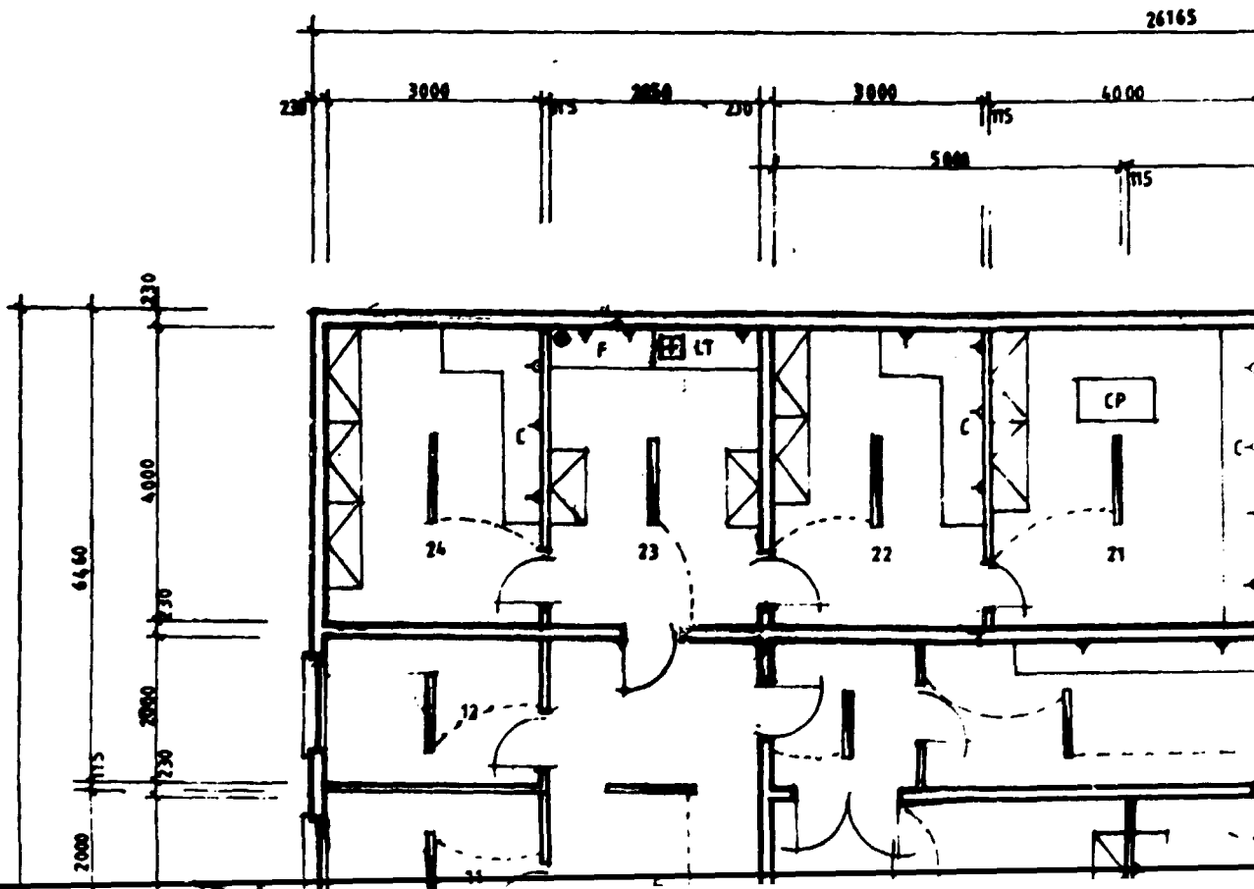
LITERATURE

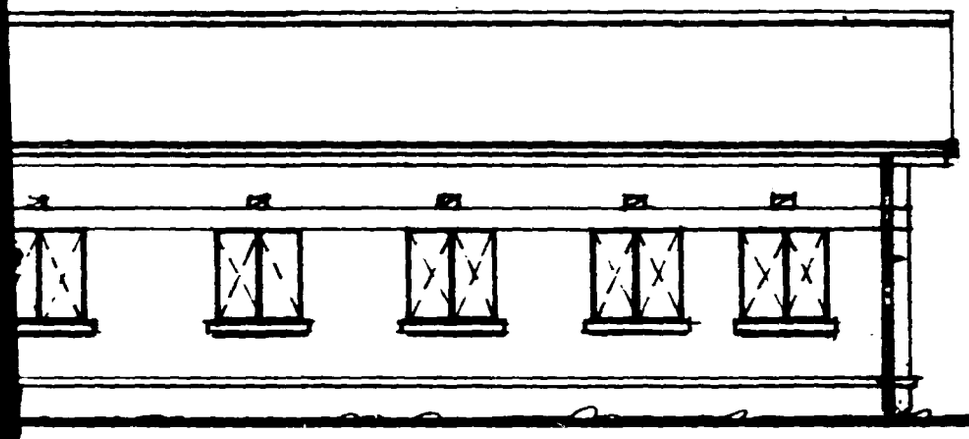
1. Weights and Measures Act (Cap. 48:04), (1960)
2. Malawi Bureau of Standards Act, (Cap. 51:02), (1972)
3. Statement of Developement Policy 1987-1996, (1986)
4. Terminal Report, RP/MLW/80/003 (Dr A Geneidy), (1982)
5. Agenda No.2 MBS Mandate and Activities, Special Meeting of MBS (31.5.1990)
6. Proceedings of the Chief Executive Workshop on Quality Management and Improvement (1990)
7. Law on Metrology, OIML 1975 B.I.No.1.
8. Report of Mission to Malawi, DP/RAF/87/058 (Mr J C Maryale - Arso) (1989)
9. Planning of Metrology and Testing Laboratories (OIML, March 1986)
10. MBS Project Proposal: Construction of Laboratories, Phase III
11. MBS Project Proposal: Establishment of Industrial Metrology Laboratory.

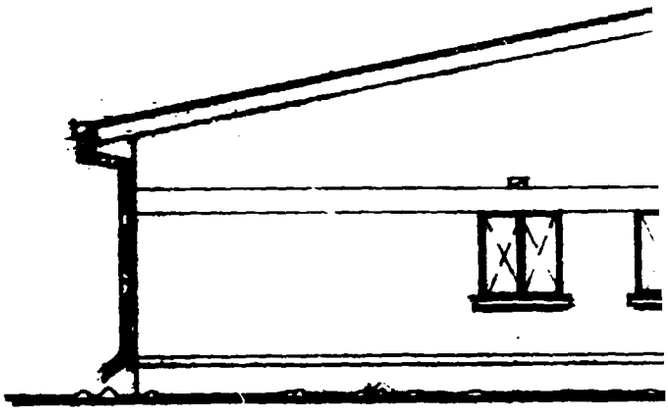
Sect 1

ANNEX VI

FRONT ELE

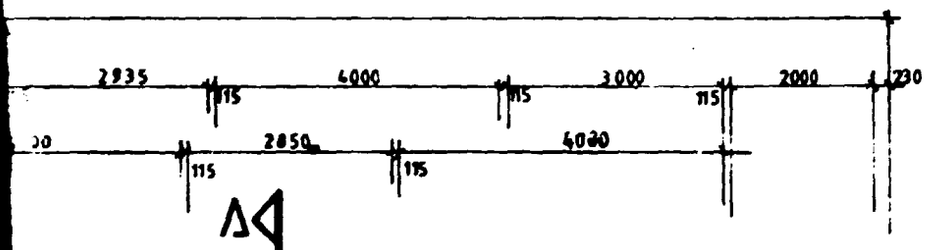


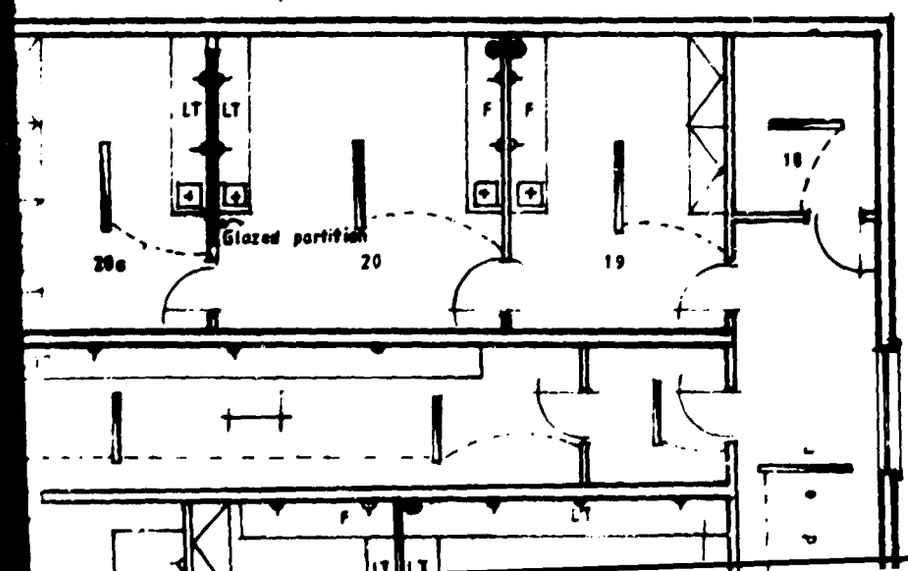


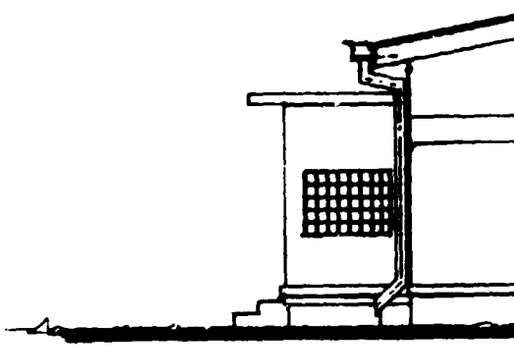


'ATION

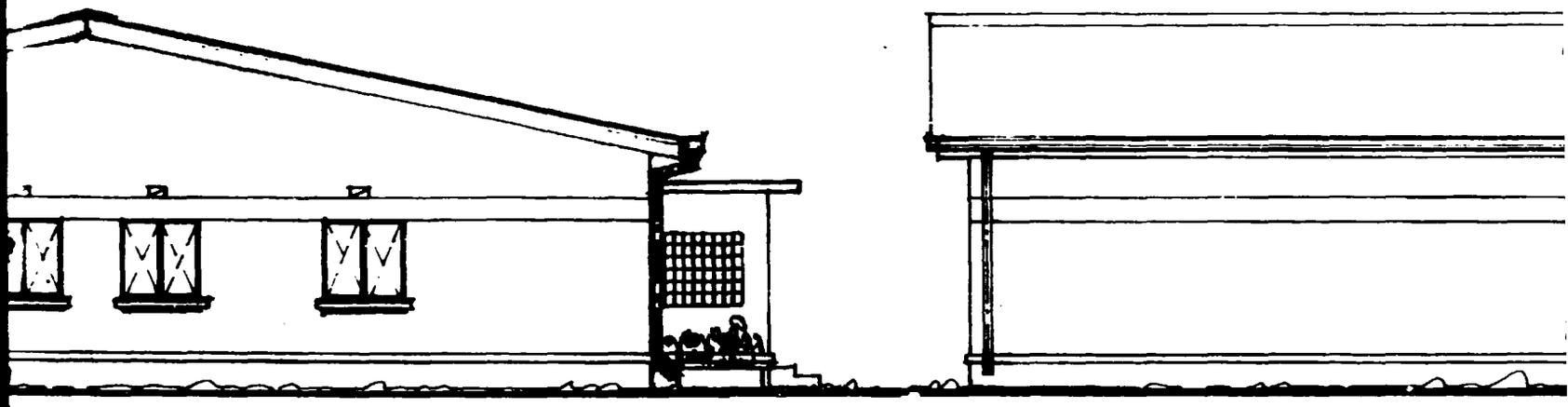
SIDE ELE





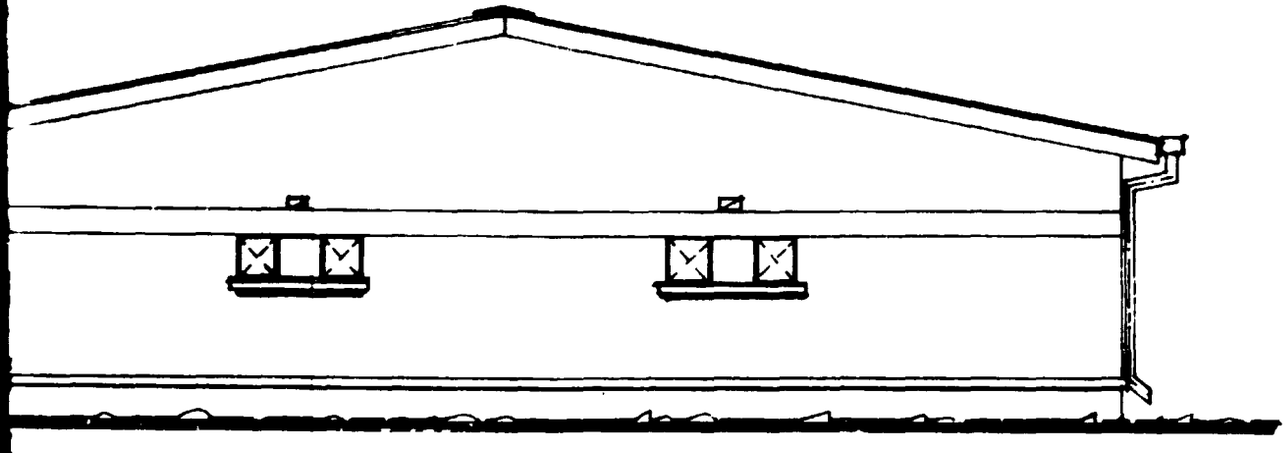


SECTION 3



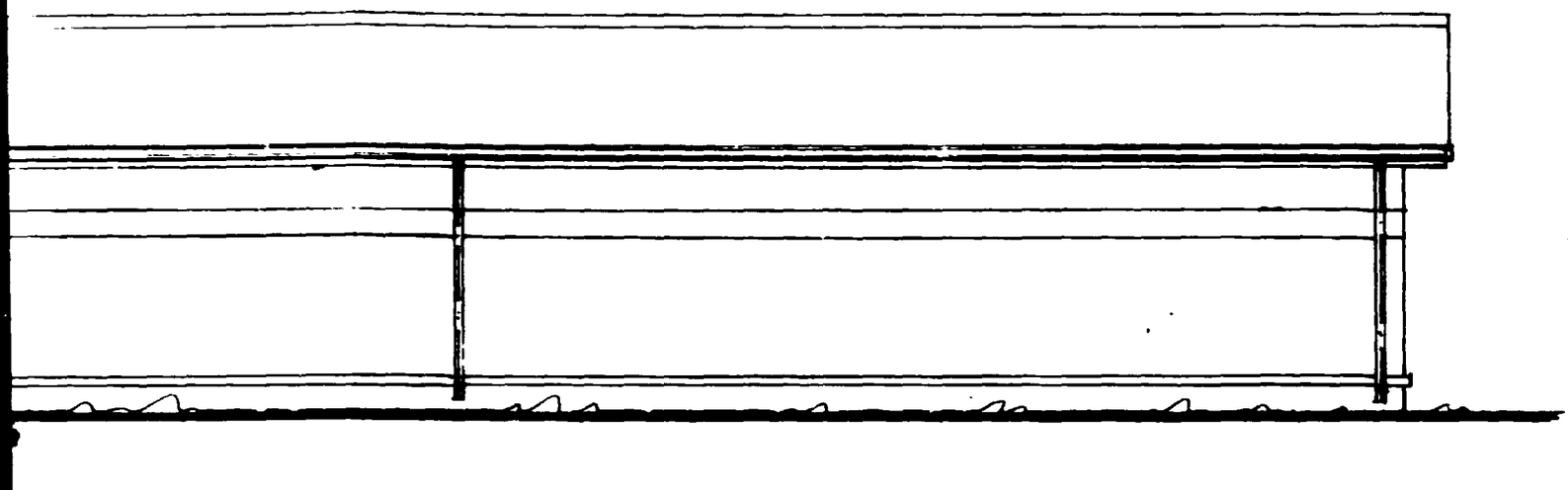
/ATION 'A'

BACK ELE



SIDE ELEVATION 'B'

SECTION 4

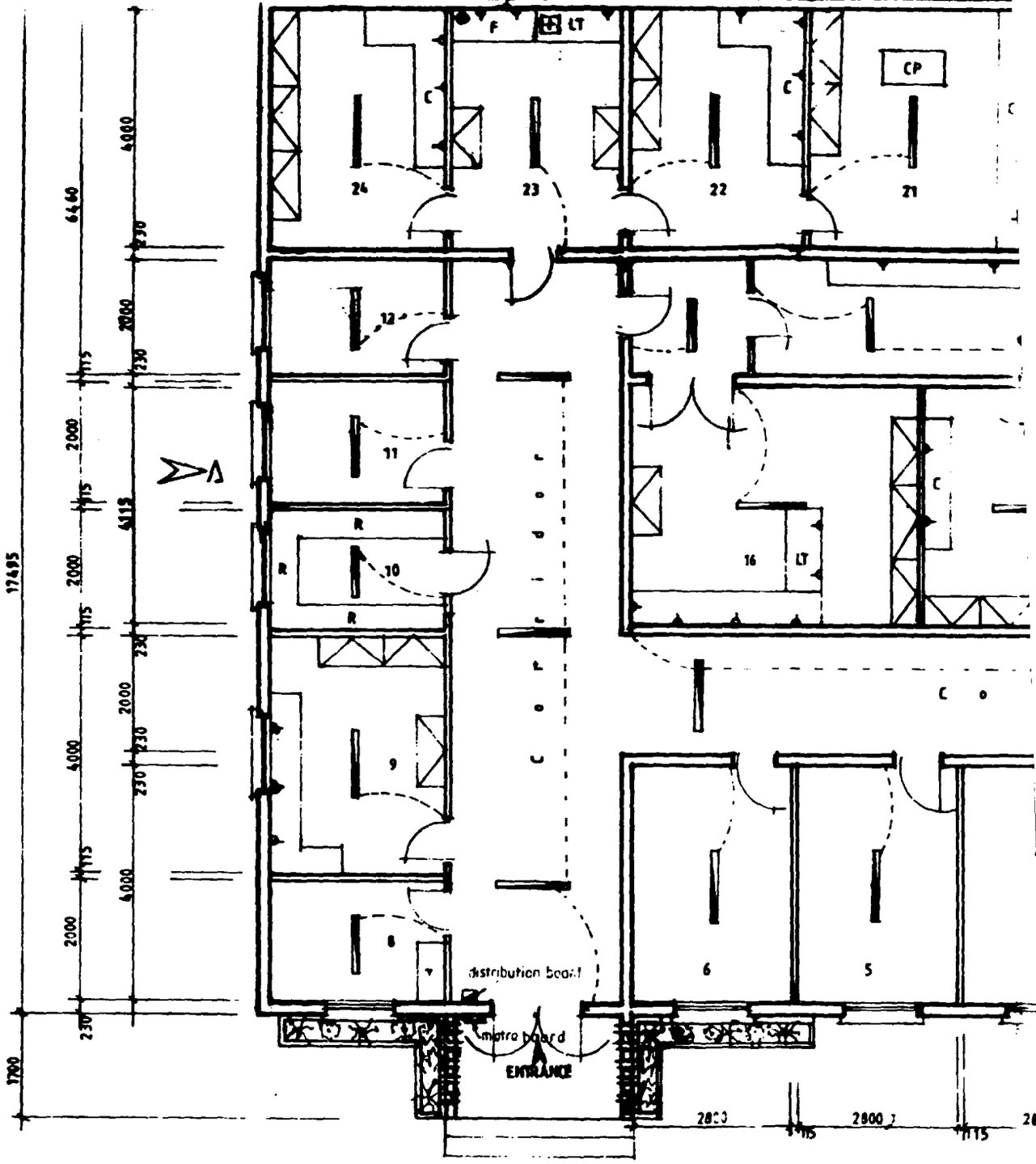


ĽK ELEVATION

LEGEND

1 OFFICE OF HEAD OF LAB.
2 SECRETARY OF HEAD OF LAB.
3-6 OFFICES
8 RECEPTION
9 REPAIR / WORKSHOP
10 STORE
11-12 TOILETS — WASHROOMS
13 DENSITY + PM - METRES LAB.
14 PREPORATORY ROOM.
15 LENGTH LABORATORY
16 FORCE, PRESSURE, HARDNESS (ENG) LAB.
17 TAPE CALIBRATION
18 AIR CONDITIONING
19 PREPORATORY ROOM
20-20a TEMPERATURE LAB.
21 MASS LAB.
22 CALILRATION + PATTERN APPROVAL BALANCES
23 PREPORATORY
24 VOLUME (CAPACITY) LAB

SYMBOLS

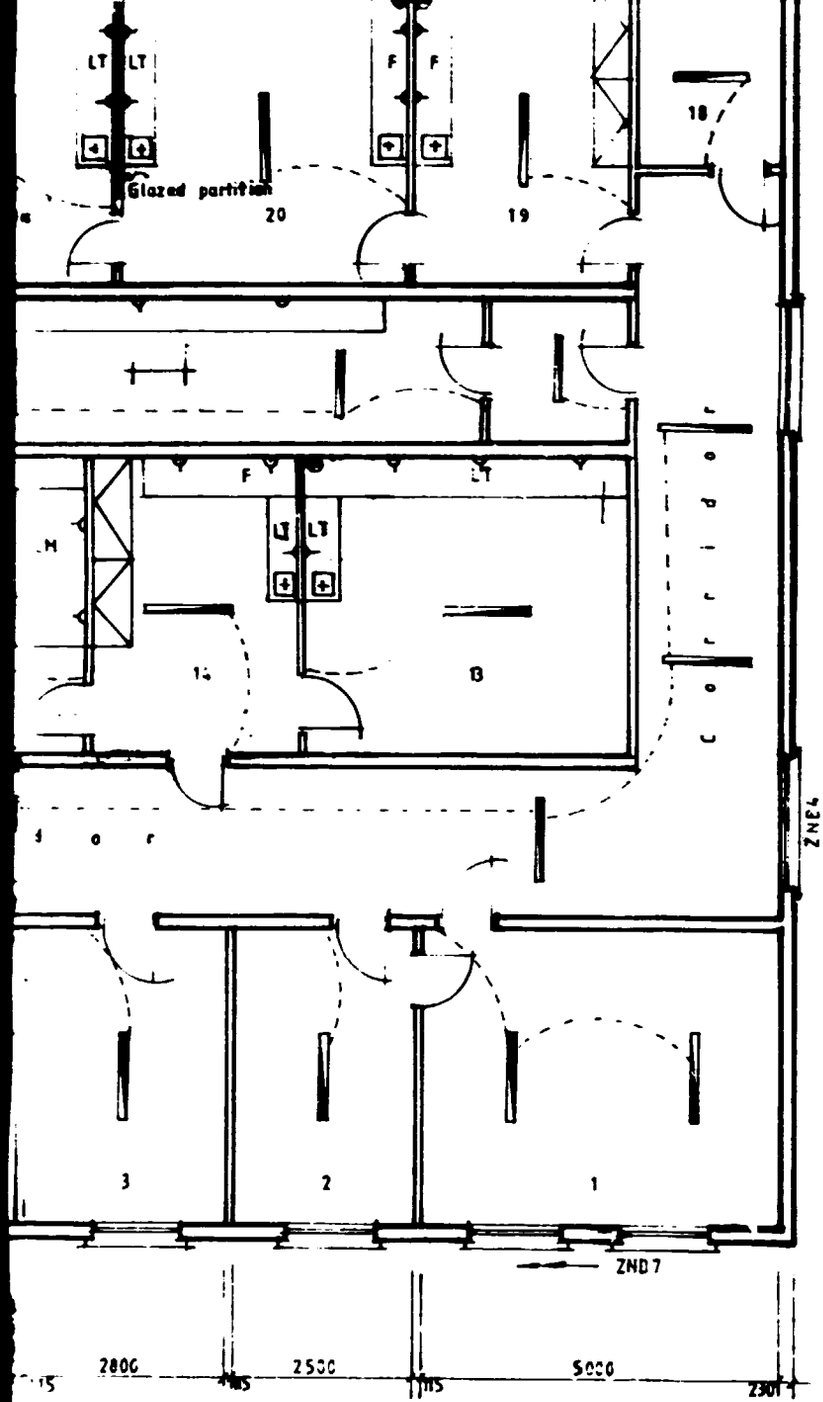


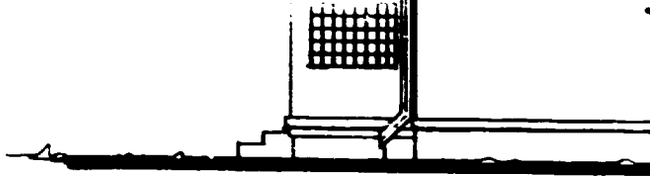
FLOOR PLAN

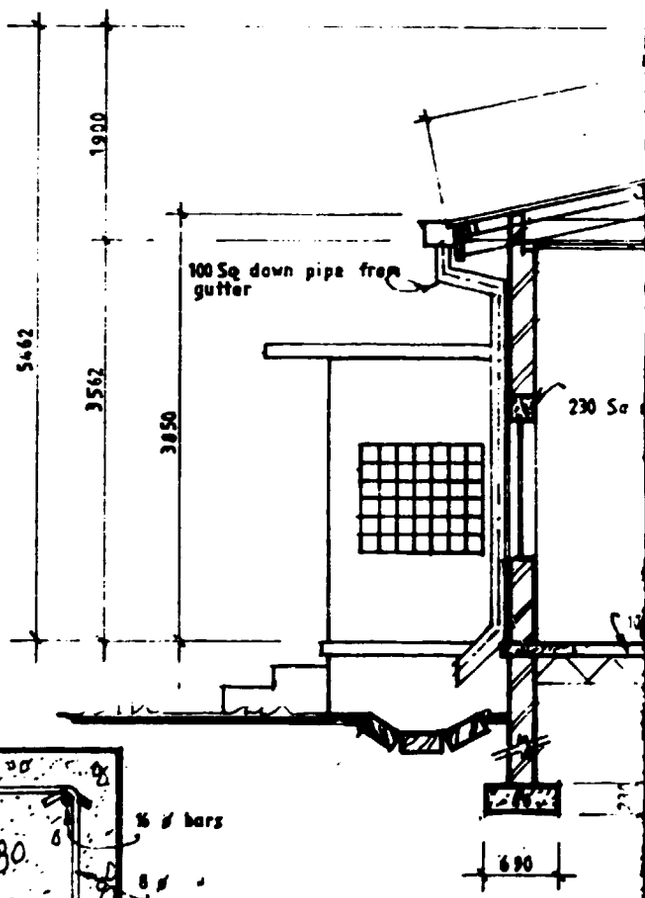
Scale. 1 : 75

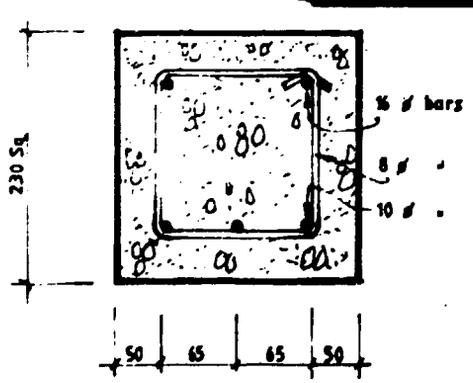
SECTION 5

M.B.S INDUSTRIAL METROLOGY LABORATORY









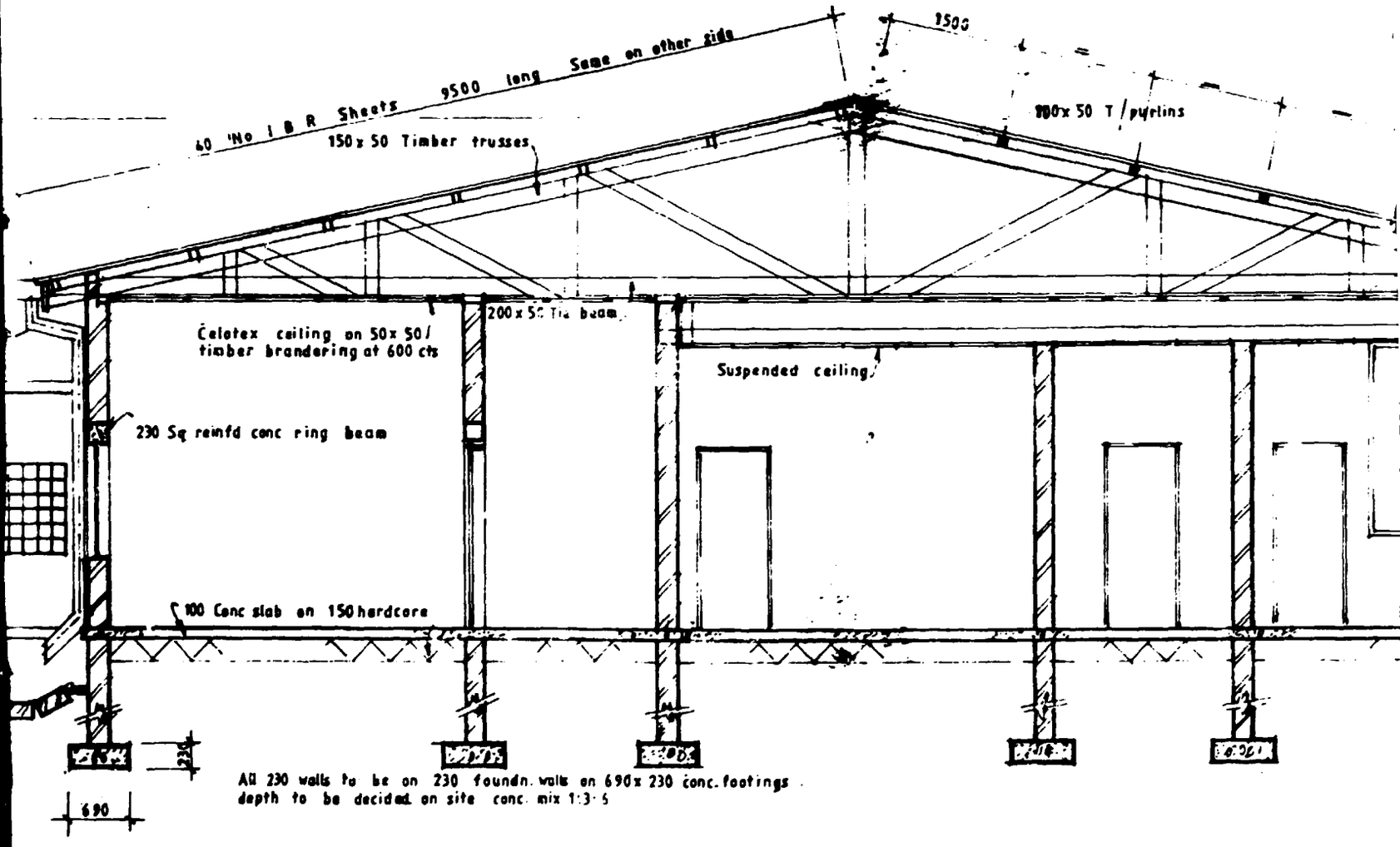
RING BEAM DETAIL

Scale 1:5

SECTION 6

JILDING. Suggested Layout, Installations and Laboratory

SIDE ELEVATION 'B'



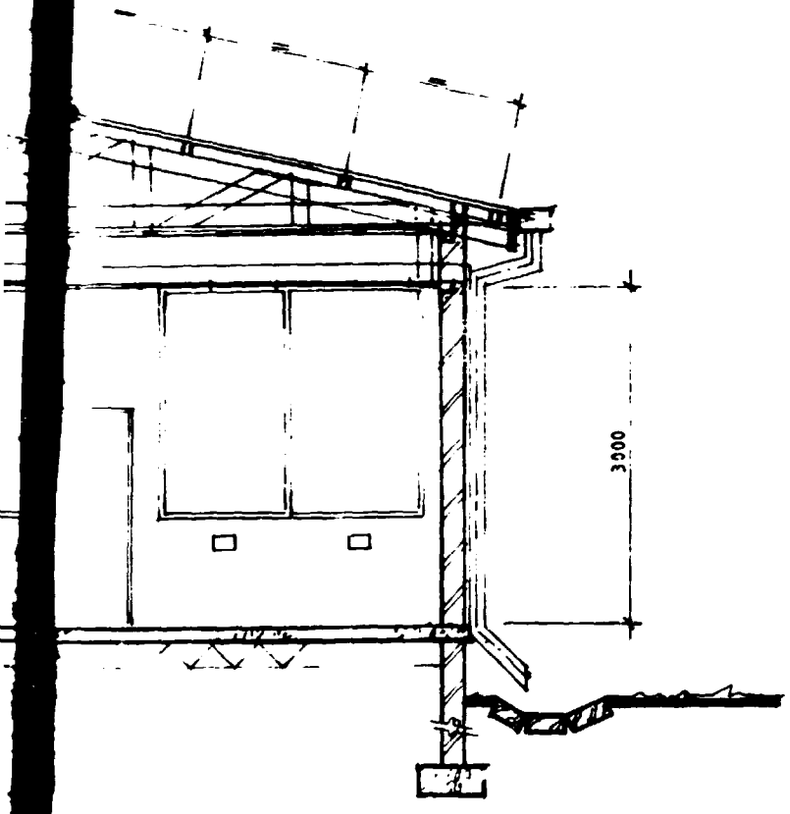
SECTION A–A

Scale 1: 50

SECTION 7

tory Furniture

11-12 TOILETS - WASHROOMS
13 DENSITY + PM - METRES LAB.
14 PREPORATORY ROOM.
15 LENGTH LABORATORY
16 FORCE, PRESSURE, HARDNESS (ENG) LAB.
17 TAPE CALIBRATION.
18 AIR CONDITIONING
19 PREPORATORY ROOM
20 - 20a TEMPERATURE LAB.
21 MASS LAB.
22 CALILRATION + PATTERN APPROVAL BALANCES
23 PREPORATORY
24 VOLUME (CAPACITY) LAB



SYMBOLS

- LAB CUPBOARD 1200 × 500 × 1800
- LT — LAB TABLE 1200 × 700 × 760
- C — CONCRETE TABLE ACCORDINGLY × 700 × 760
- ULM — CONCRETE STAND FOR UNIVERSIAL LENGTH MASS MACHINE
- F — FUMF CUPBOARD
- WATER SINK
- EL SOCKET 220v
- 3 PHASE (380v) SOCKET
- CP — CONCRETE PILLAR
- R — RODE WITH SHELVES 200 × 600 × 1800
- TUBE LIGHTING
- 20 - 20a — GLASS PARTITION

SECTION 8

	Drawn by	