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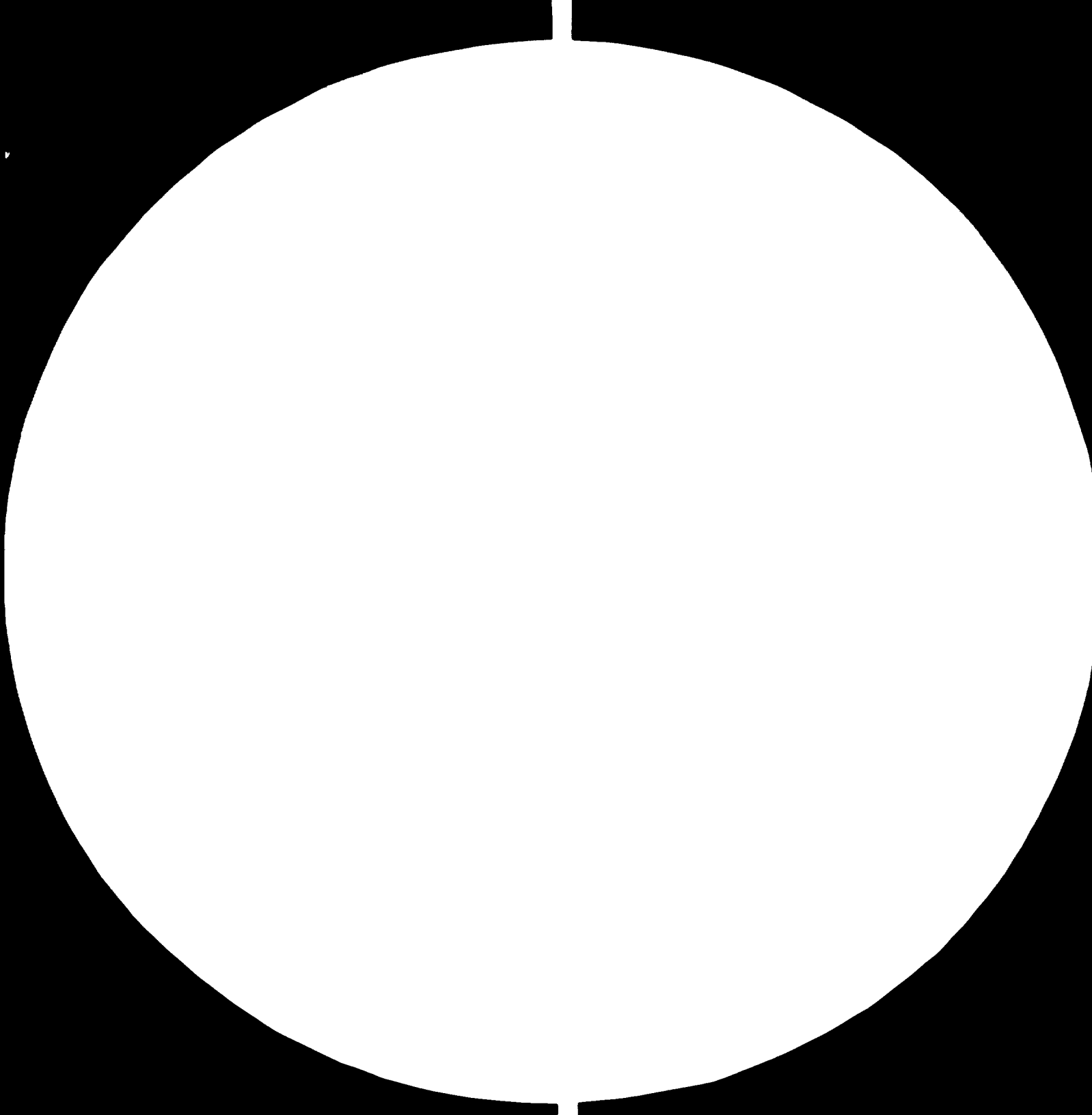
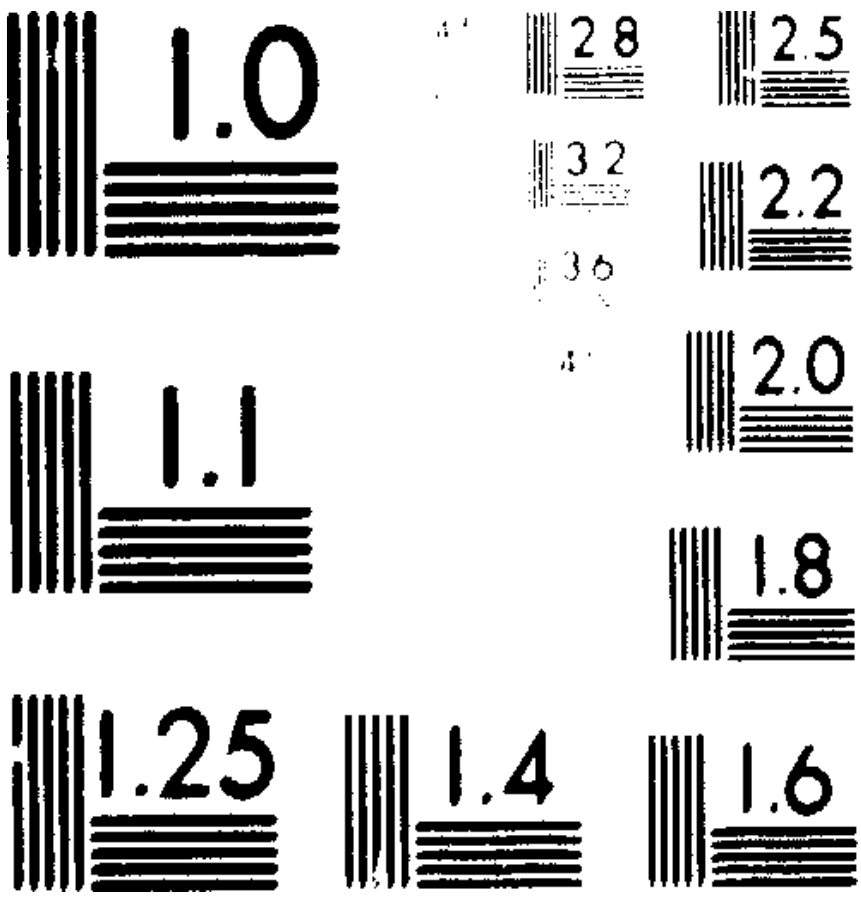
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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FINAL REPORT

ON

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METROLOGY ACTIVITIES

IN THE FRAMEWORK OF

DP/BAR/77/005

ORGANIZATION AND ADMINISTRATION OF

NATIONAL STANDARDS INSTITUTION

IN BARBADOS

(Phase II)

-- Sep. 1980

Prepared by

Dr Anwar B El-Tawil

UNIDO METROLOGY ADVISER

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C O N T E N T S

SUMMARY

This Report deals with the metrology aspects of DP/BAR/77/005 - Organization and Administration of a National Standards Institution, a joint project of the United Nations Development Program (UNDP) and the Government of Barbados with the United Nations Industrial Development Organization (UNIDO) as the executing agency.

The report starts with background information on Barbados and the conditions that led to the establishment of the first phase of the Project as DP/BAR/72/004, and its continuation in a second phase - DP/BAR/77/005.

It includes a short survey of the metrology situation in Barbados prior to the implementation of Phase II of the Project, and an account of the metrology activities carried out within the framework of Phase II during the mission of the UNIDO Metrology Adviser from May 1973 to August 1980.

The report contains recommendations for future action in the field of metrology, and is supplemented by equipment lists, calibration schemes, structural plans, outlines of training programs etc.

INTRODUCTION AND BACKGROUND INFORMATION

Barbados is a beautiful island in the Eastern Caribbean. The population of Barbados in 1980 is about 270 000 inhabitants in an area of 430 square kilometres. Barbadians are English-speaking, and the country is a member of the Community of English Speaking Caribbean Countries "Caricom".

With a per capita GNP of over US $ 2 200 and a literacy rate of 98% Barbados belongs to the more developed of developing countries.

The main components of GNP at present are tourism and the traditional sugar industry. However, the years after independence in 1966 witnessed a substantial expansion in the industrial sector. The Government of Barbados has endeavoured to encourage this expansion as a guarantee against fluctuations in GNP due to bad crops, low sugar prices or a weak tourist season. The Government has established an Industrial Development Corporation, a number of industrial parks and it gives various incentives to local and foreign investors. Among the important attractions of the island for investors are: a literate, trainable workforce, good internal and external communications and a reasonably well developed infrastructure.

With the progress of industrialization in the island the need became apparent for an institutional infrastructure. The Government has started alone and in cooperation with international agencies and foreign governments to develop a number of institutions, to serve the development needs of the country.

One of these institutions was the Barbados National Standards Institution (BNSI) established in 1973 as a result of cooperation between the UNDP and the Government of Barbados. This cooperation took the form of a joint development project = "DP/BAR/72/004 - Organization and Administration of National Standards Institution" - The executing agency was UNIDO.

Under this Project the Government supplied administrative offices, local staff and constructed a new building for a laboratory complex for testing and metrology. The UNDP supplied equipment, trained local staff and delegated 3 international experts until the Project was terminated in 1976 before the laboratories became fully operational. UNDP total contribution by that time was US $ 261 479.

Subsequently, it was agreed to add a second phase to the Project. This phase was planned to start in 1978 and to continue for 3 years. The new phase (executed as DP/BAR/77/005) involved the delegation of one metrology and one quality control adviser each for one year, and the supply of equipment to the value of US $ 95 000. UNDP total contribution in this phase was planned to be US $ 199 800, thus bringing the total UNDP contribution in the project to US $ 461 279.

The general objectives of Phase II of the Project are as follows:

1. To promote the quality of Industrial production in the country and to ensure optimum economic use of local resources.

2. To assist in establishing a system of quality marking and inspection aimed at serving local consumers and consolidating the country's position in export markets.

3. To assist in the changeover to the Metric System in Barbados.

4. To upgrade the metrology system in the country with a view to:

   a - assuring equity in trade.
   b - promoting and providing the necessary scientific basis for efficient measurements in industry and in local scientific and technological institutions.

This report deals with the metrology aspects of the Project. The report contains:-

I. A survey of the metrology situation prior to the implementation of Phase II of the Project.

II. An account of metrology activities carried out within the framework of Phase II of the Project.

III. Recommendations for future action in the field of metrology.

I. A SURVEY OF THE METROLOGY SITUATION IN BARBADOS PRIOR TO THE IMPLEMENTATION OF PHASE II OF THE PROJECT (MAY 1979)

The metrology system in Barbados before the establishment of BNSI was an outdated system based on the Imperial foot-pound units. After the establishment of BNSI in 1973 an effort was made to modernize the system and to change over to the International (Metric) System of Units (SI). The following is an account of the actual metrology situation in Barbados in 1979, prior to the field implementation of Phase II of the present project.

1.1 Control of Commercial Weights and Measures

The control of Commercial Weights and Measures in the public markets of Barbados was assigned to the Superintendent of Markets who has a Weights and Measures Branch (WMB) attached to him. The WMB employs one (1) skilled worker with some experience in commercial weights and measures but no formal qualifications and one assistant. The WMB used to perform on demand adjustment and calibration of counter scales, platform weighing machines, vehicle weighbridges, capacity measures -- etc. No register was kept of commercial weights and balances and no regular periodic verification was performed.

The equipment of the WMB was in the Imperial System of Units. It included masses for checking commercial balances and weighbridges up to 10 tons and capacity measures up to 1 gallon. The equipment was very old and in bad condition. No calibration of the equipment was done for a very long time, and checking of samples of masses used as standards by the WMB at BNSI laboratories showed deviations tens of times more than the internationally accepted tolerances on masses of this category.

There was no state control of the following commercial weights and measures:

- Scales used in private shops.
- Petrol measuring pumps in filling stations (adjustment made by the oil companies)
- Computerized scales used in supermarkets (repair and adjustment by manufacturers' agents)
- Prepackaged goods
- Electricity, water and gas meters (repair and adjustment made by the respective corporations which are joint government-private companies).

The premises of WMB are not suitable for keeping the standards required for commercial weights and measures.

1.2 Metrology Legislation and Metrication

On the initiative of BNSI a new weights and measures act was prepared and passed by Parliment in 1977. This act is based on the modern principles of legal metrology. It stipulates the use of a hierarchy of national standards, their custody and verification. It provides for the employment of Inspectors of Weights and Measures headed by a Chief Inspector. It stipulates type approval, periodic and sudden checks, stamping of commercial weights and measures. The act introduced the Metric System of Units (SI) and provided for a phased metric conversion. The act provided for Metrology Regulations to be issued by the Minister to govern the organizational and technical sides of its implementation. However, till the beginning of Phase II of the Project no Regulations were issued and no inspectors of weights and measures were appointed.

1.4 Metrology Laboratories of BNSI

The ground floor of the Laboratory complex of BNSI was devoted to metrology laboratories. This represents an area of 213 square metres.

This area was only partially subdivided by incomplete partitions. A number of conditions important for the conservation and proper operation of metrology equipment have not been observed. For example, single glass windows consisting partially of open louvres were installed that let the dust in. Windows facing south and west were letting in direct sun rays for part of the day according to the season.

The construction of the metrology laboratories in this incomplete form was finished after the departure of the last Project Manager. Part of the equipment was installed by BNSI staff, the rest was still in the store.

The metrology equipment available in the project at that time was not sufficient to satisfy the basic needs of legal and industrial metrology in the country, especially in view of the metrication process. Moreover, a number of items of equipment were damaged in transit, due to mishandling or simply due to improper choice (e.g. brass weights rusted due to the humid climate). A list of metrology equipment provided in Phase I of the project is given in Annex 2.

One member of BNSI was available for metrology work. He is an electronics engineer who attended a UNIDO general metrology training course in the USSR but has not received training in any of the specific branches of metrology such as mass measurement or length measurement.

A Metrication Board was set up to supervise the change-over to the Metric System. By the time of commencement of Phase II of the Project some commercial weights and measures had been already converted. Petrol stations were selling in litres, some locally prepackaged products such as beer and milk already had metric sizes.

In the field of assessment of alcoholic strength of liquors for the purpose of custom duties the English Proof System was still applied although the rum industry and the Customs Department were aware of the decision of the EEC to convert fully to the metric OIML system by the beginning of 1980.

1.3 Industrial Metrology

The main industry in Barbados is still the traditional sugar industry which contributes 7% of GNP. Other industries are: rum industry, beer and carbonated light beverages, wooden and metallic furniture, kitchen utensils, batteries, paints, insecticides, pharmaceuticals and the newly introduced electronic industry. There is an oil refinery, a foundry and a number of building material factories.

Some local factories have standards for their own use such as dead weight testers for pressure gauges and standard thermocouples and furnaces for testing temperature measuring devices. However, many factories do not possess any standards and have to send their instruments abroad for adjustment and calibration.

The weighbridges and platform balances used by the factories were being verified by the WMB. The majority of these balances were in the Imperial System of units. However, most factories had ordered new metric weighing heads for the conversion of their weighbridges. Most of the new factories had metric instruments.

A number of metrology publications were available in BNSI. They were in the possession of BNSI director and staff members and in the Library. They included some standards of the International Organization of Legal Metrology (OIML), of the International Organization for Standardization (ISO) and the national standards of ISO member bodies in the field of metrology.

II. AN ACCOUNT OF METROLOGY ACTIVITIES CARRIED OUT IN THE FRAMEWORK OF PHASE II OF THE PROJECT

The objectives of Phase II of the Project in the field of metrology can be detailed as follows:

1. Setting up the metrology laboratories of BNSI and making them operational by:

   a - Executing the necessary subdivision of the area of the laboratory building devoted to metrology, and carrying out the necessary structural changes to make it suitable for housing the national standards and for performing metrology work.

   b - Providing and installing the necessary equipment to satisfy the basic metrological needs of the country.

   c - Establishing procedures for the calibration of standards and working instruments and providing the necessary documentational support for metrology work.

   d - Training counterpart staff in metrology work.

2. Assisting in the metric changeover and in upgrading the legal metrology services in Barbados by:

   a - Preparing Metrology Regulations.

   b - Training of Inspectors of weights and measures.

   c - Offering technical support of the legal metrology activity.

The following is an account of the activities carried out during the mission of the Metrology Adviser from May 1979 to August 1980.

II.I Subdivision and Structural Modification of the Metrology Laboratories

A plan for subdividing the sub-floor of the laboratory building into a number of metrology laboratories and for finishing these laboratories in conformity with the requirements of metrology work was submitted to the Government by mid-July 1979. The plan was intended to minimise the construction work while fulfilling the following requirements necessary for metrology work.

1. To protect the equipment from dust by providing the laboratories with dust-proof windows.
2. To protect the equipment from direct sun rays by providing sun shades outside the buidling on the sides subjected to the sun.
3. To provide temperature and humidity control in all metrology laboratories without causing strong air currents in the neighbourhood of equipment sensitive to them such as precision balances. For this reason the access to the balance room was provided through an ante-room in which the air conditioner was installed. The two rooms were connected through a louvred partition. This ensured good temperature stability and freedon from air currents in the balance room.
4. To facilitate sharing of equipment between laboratories using similar types of equipment. For example, the layout provided for the thermodynamic measurement laboratory to be adjacent to the electrical measurement laboratory to facilitate the use of precision equipment for measuring e m f and electrical resistance for the calibration of thermocouples and resistance thermometers. Annex 3 shows a schematic plan of the metrology laboratories.

The architectural working drawings were prepared by October 1979. However, due to financial reasons, the actual structural work started only in April 1980 and was completed by the end of May 1980. It cost about US $ 15 000.

II.2 Provision, Installation and Operation of Metrology Equipment

A survey of the metrology needs in Barbados and of the equipment supplied in Phase 1 of the Project showed that some supplementary equipment was needed to achieve the following objectives.

1. To permit accurate calibration of BNSI standards for example, two Mettler balances of capacity 200 g reading to 0,01 mg and 1 000 g reading to 0,1 mg were ordered for the calibration of mass standards.

2. To permit convenient, safe use of BNSI standards. For example, an extra set of working volume standards was ordered to be used for the calibration of systems for the measurement of drinkable liquids such as liquors and milk in addition to the available set that will be now restricted to the calibration of systems for non-drinkable liquids such as petroleum products. The use of one set of standards for both types would require extensive cleaning operations and would still risk contamination of the systems for drinkable liquids.

3. To increase the measurement and calibration capabilities of BNSI Metrology Laboratories to cover most of the present metrological needs of the country. This involved provision of new types of standards and instruments such as standard thermometers and calibration baths, standard hydrometers and alcoholometers, thread measuring wires, DC and AC calibration facilities etc.

The supplementary equipment was chosen on the basis of actual needs starting from the lowest application level and going upwards in the direction of higher accuracy only so far as to establish a working calibration scheme in each metrology branch. Annex 4 shows the calibration schemes (hierarchies of standards) for the different metrology branches.

It should be mentioned here that ordering the equipment was not without problems. Thus on the arrival of the Metrology Adviser in May 1979, of the total equipment component of US $ 95 000 about US $ 26 000 were already spent for equipment and chemicals requisitioned in 1978. A project revision dated 1979-05-31 further reduced the equipment component by US $ 35 000. To make up for these reductions extra funds were requested and, fortunately, it was possible to re-allocate US $ 30 000 to the present Project from other country projects.

Due to these circumstances it was not possible to provide all the equipment necessary for the basic metrological needs of Barbados at this stage. For example, it was not possible to provide the heavy masses necessary for the verification of platform balances and vehicle weighbridges that are being converted to the Metric System and the heavy balance necessary for their adjustment due to their high cost (about US $ 47 000 for 16 tonnes of cast iron masses and about US $ 15 000 for a 500 kg precision balance).

The equipment lists were arranged in 3 priority categories: the first and second included the equipment to be purchased in 1979 and 1980. The third equipment list included equipment that was still needed but for which no funding was available at present. Due to inflation a number of items had to be transferred from list 2 to list 3 because they could not be financed at the current prices.

within the available budget. Equipment list 3 is intended as a reference for future action. It is given as part of annex 2.

While waiting for newly ordered equipment to arrive the equipment delivered in Phase I of the Project was repaired, serviced and upgraded. Examples of this work are:

Ordering a replacement for a damaged knife-edge of a precision balance and of the lost rider of a microbalance. The new parts were received and installed, and the relevant balances (together with other precision balances) adjusted and calibrated.

Calibrating the secondary standards of mass.

Cleaning 3 sets of brass masses from 20 kg to 1 g from the rust that appeared on their unprotected bottom sides. After cleaning the bottom sides were covered with a varathane wear-resistant varnish and the masses were adjusted and calibrated. These sets are now being used as working standards for legal metrology work.

Providing a 120 kg Avery platform balance with a scale and pointer and adjusting its sensitivity to a maximum value, thus enabling accurate weighings to be made with this instrument of previously medium accuracy.

Calibrating volume working standards by the gravimetric method.

After the completion of the structural work in the metrology laboratories, and thanks to an extension of the mission of the Metrology Adviser by 3 months, it was possible to install the equipment delivered in Phase I and the newly delivered equipment in place and to start its operation.

CALIBRATION PROCEDURES AND METROLOGY DOCUMENTATION

The first step to establish documentational support of the metrology work in BNSI was to review the metrology publications available in the institution such as international and national standards and other publications dealing with metrology. Next, a number of important publications were requested from the International Organization of Legal Metrology (OIML) and the National Bureau of Standards of the USA to complement the available publications. Fortunately, it was possible to obtain a number of important publications from these two bodies free of charge. Finally some publications were ordered through the UNIDO.

The metrology publications so gathered were classified and abstracted in a bibliographic document entitled: "A Guide to Metrology Publications in BNSI". This document covers about 300 titles and gives for each title the publisher and date, the corporate and personal author, the number of pages and illustrations plus a short abstract about the contents of the publication. Copies of this document were distributed to all BNSI staff members, to member bodies of BNSI and to other persons and organizations interested in metrology in Barbados.

Calibration procedures for BNSI standards as well as for standards and instruments of other bodies were established as far as possible in line with the relevant international standards. In some cases it was recommended to follow the procedure given in a certain international standard or in a publication of a standards body of a developed country (such as the NBS) when such a publication was available and adequate for the local needs. In other cases special Calibration Procedures were established by the Metrology Adviser taking into consideration the local equipment and conditions.

The Calibration Procedures specially established for use in BNSI Laboratories contained a principle of the calibration method, equipment needed, general precautions and rules for handling the equipment as well as detailed instructions for carrying out the calibration and for calculating the results. Each Calibration Procedure is supplemented by registration forms to facilitate recording and evaluating test data for each type of calibrated instrument.

The registration forms are designed in such a way as to facilitate the calculation of the results either using a hand-held programmable calculator or manually. Each form actually contains all the necessary formulae and special spaces to perform the calculation manually step by step. It is also possible to feed the test data into a programmable calculator (Texas Instruments Model TI-59) and to use pre-recorded programs to perform the calculations in a few seconds. The programs established for this purpose are available on magnetic cards and they are also annexed to the relevant Calibration Procedure for ready reference if, for some reason, the magnetic card is not available.

Annex 5 gives a list of the Calibration Procedures established especially for BNSI or recommended for use by the Institution. Copies of the Calibration Procedures published during Phase II of this Project were sent to UNIDO. They are also available on request from BNSI.

TRAINING OF COUNTERPART STAFF

Two types of training were undertaken during Phase II of the Project:

- Theoretical training
- On-the-job training.

THEORETICAL TRAINING

1-A training course in General Metrology was conducted for one month in August-September 1979. The participants were 10 BNSI staff members. The course included lectures by the Metrology Adviser (46 hours) and discussions and presentations made by the participants on application - oriented study points assigned to each (34 hours). Each presentation included the results of theoretical and/or practical measurement and calibration work.

The outline of the course is given in Annex 6(a). The lecture notes were sent to the UNIDO and are also available on request from BNSI.

2-A short training course in the Assessment of Alcoholic Strength and Metrication of Alcoholic Duties was conducted for two days in February 1980. The participants were Customs' Officers, specialists from the local rum industry and BNSI staff. The course included Lectures by the Metrology Adviser and solution of practical problems by the participants. The course was repeated twice with twenty participants taking part in each session.

The outline of the course is given in Annex 6(b). Lecture notes were sent to the UNIDO and are also available on request from BNSI.

ON-THE-JOB TRAINING

On-the-job training of BNSI staff was conducted whenever practical work was being done. Counterpart staff were trained in the maintenance, repair, adjustment and calibration of measuring equipment such as precision balances, standard masses, volume standards etc.

Members of BNSI staff always accompanied the Metrology Adviser on trips made to industrial firms to adjust or calibrate their standards and measuring instruments.

This training included the execution of the calibration procedure, recording the test data, performing the necessary calculations manually or on a programmable calculator.

BNSI staff members were also trained in the verification of metric commercial weights and measures in accordance with the Draft Metrology Regulations. This included examination and evaluation of conformity to the specified tolerances. They were also acquainted with construction details of these weights and measures.

METROLOGY REGULATIONS

In order to implement the Weights and Measures Act of 1977 it was necessary to establish Metrology Regulations that define the technical and organizational conditions for the implementation of the Act.

Draft Metrology Regulations were prepared by the Metrology Adviser by November 1979. The Regulations include:

PART I : PRELIMINARY

- Modalities of promulgation, commencement and revision. Interpretation of terms Part II Organization of Legal Control of Commercial Measuring Devices and of Quantities of Prepackaged Goods.
- Devices subject to control.
- Periodic verification.
- Duties of Chief Inspector
- Custody of National Standards and Transmission of the Units to the working standards used by inspectors.
- Pattern approval procedure.

- Voluntary Registration of servicemen.
- Checking of quantity of prepackaged goods Part III. Technical and Metrological Regulations for Commercial Measuring Devices.
- Technical and Metrological conditions that must be fulfilled by masses, weighing instruments, length measures, capacity measures and petrol measuring pumps.

The Regulations are supplemented by 8 schedules giving the official stamp-marks, fees for verification work, sampling plans for checking prepackaged goods and permissible tolerances on the various types of commercial measuring devices. The Regulations are as far as possible in line with relevant international standards.

The Draft Regulations were circulated for comments, then they were discussed in a meeting in BNSI attended by representatives of importers and agents of manufacturers of commercial measuring devices. As a result of the comments and discussions a second draft was prepared in March 1980 and sent to the Ministry for promulgation.

TECHNICAL SUPPORT OF METRICATION AND OF LEGAL METROLOGY ACTIVITY

During the implementation of Phase II of the Project Barbados was engaged in a process of changeover from the Imperial System of Units to the Metric (SI) System. This process usually involves many aspects of national activity such as legislation, education, commerce, industry, science and technology. The changeover usually takes place over a long period of time.

During the implementation of Phase II of the Project many problems concerning the metric changeover did arise, and BNSI showed important initiative toward their solution. The following are some examples of this activity.

- BNSI offered consultation for the amendment of a number of laws such as the Rum Duty Act, the Customs Act -- etc. in accordance with the metric system.

  Metric equivalents were computed, conversions were proposed.

- Consultation was offered for the changeover to the metric system of assessment of alcoholic strength of liquors (OIML Method). Advice was given on the methods to be used and the equipment required. A specialized training course was conducted in this field.

- Consultation was given by telephone and personally on questions concerning the conversion to the Metric System. For this purpose BNSI established a "Metric Hotline".

- With the advance of metrication and as new metric weights and measures were imported into the country they were brought to BNSI for verification. During 1980 hundreds of balances and weights were verified under the supervision of the Metrology Adviser and with the participation of BNSI staff. This offered an excellent opportunity to explain the relevant parts of the still draft Metrology Regulations and to give training in their implementation. It was also a good opportunity to point out the acceptable and unacceptable constructional details of these weights and measures, thus initiating BNSI staff members in pattern approval of commercial measuring devices.

III. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE ACTION IN THE FIELD OF METROLOGY

National Institutions such as the Barbados National Standards Institution take a long time, considerable expenditure and the sustained effort of many specialists and organizers to establish firmly. The inputs received from both the UNDP and the Government during Phase I and Phase II of the present Project have laid the foundations for an operational national standards institution in Barbados. However, time, staff and finance limitations did not permit the fulfilment of all aspects of this important institution at this stage. A lot remains to be done to ensure that the development process represented by this Project becomes irreversible and evolves further to have a positive impact on the national economy and the quality of life in Barbados.

The following is a number of recommendations intended to promote the achievement of the objectives of the Institution in the field of metrology.

Metrology Equipment

As a result of limited funds Equipment List III could not be financed in the framework of Phase II of the present Project. Moreover, some items were transferred from Equipment List II to Equipment List III due to inflation.

Items 1, 2 and 3 on this List represent the equipment necessary for the verification of metric platform balances and vehicle weighbridges. This equipment is necessary for the successful metrication of weighing devices used in factories and by wholesale traders all over the island, as well as in the harbour, the airport etc.

In this concern two options are open:

1 - To order the items new as specified at a total cost of about US $ 60 000. This option would permit calibration of metric platform balances and weighbridges as they are imported or converted to the metric system, while continuing to calibrate the non-metric ones as before by the Weights and Measures Branch.

2.- To rework locally the 50 lb and 500 lb masses in the custody of the Weights and Measures Branch to metric values (20 kg and 225 kg) by removing some material from them by milling or scraping in the Barbados Central Foundry. The masses should then be painted with an epoxy-paint.

It would then be necessary to purchase only the 500 kg balance for the adjustment of masses and ten extra 500 kg masses to bring the total masses available to about 15 tonnes. This option would cost about US $ 35 000 only, but it would mean that the weighbridges graduated in the pound system cannot be verified after the rework operation.

The rest of the items on Equipment List 3 are intended to increase the capabilities of BNSI in the field of industrial and scientific metrology. They can be purchased when extra funds become available. This can be done at once, or gradually as the need arises (e.g. due to expansion of the electronic industry).

Metrology Lab. Building

The present metrology lab. building should remain adequate for local needs for many years. However, if heavy masses for the verification of weighbridges are acquired and placed in the custody of BNSI it will be necessary to build a weatherproof shed about 70 m^2 with a concrete floor to house them. It is recommended to build this shed in the vacant area to the south of the laboratory building. In that position it will be near to the external door leading to the mass preparation room. The shed must be provided with a hoisting facility and access to it by truck must be assured.

Recruitment and Training of Metrology Personnel

The operation of BNSI Metrology Laboratories and the administration of full legal metrology services in Barbados require the services of a larger number of trained specialists and inspectors of weights and measures than are available at present.

In addition to the electronics engineer now available for metrology work in BNSI, it is necessary to engage the full time services of a physicist or mechanical engineer. The two specialists must receive further training in specific metrology branches such as mass metrology, electrical metrology, thermometry etc. This training is best arranged in the laboratories of a standards institution of a developed country for several months.

The legal metrology activity will require the services of about 4 inspectors of weights and measures. The recruited inspectors must receive training in general and legal metrology.

Organization of Legal Metrology Service

In order to start the administration of modern legal metrology services in Barbados it is first necessary to promulgate the draft Metrology Regulations prepared by BNSI as soon as possible. Secondly a Chief Inspector of Weights and Measures must be appointed and the authority to implement the Weights and Measures Act and Regulations delegated to him solely.

In accordance with the Weights and Measures Regulations the Chief Inspector must cause records to be kept of all commercial measuring devices used in the country and supervise their periodic verification by Inspectors of Weights and Measures. He must initiate pattern approval of imported weights and measures and the control of quantity of prepackaged goods at trade outlets. It will be necessary to recruit and train about 4 Inspectors of Weights and Measures to assist the Chief Inspector in this activity.

From the foregoing it ensues that the Barbados National Standards Institution will in the following years still need inputs in the fields of equipment, building, local staff, expertise, training, legislative and organizational support to fulfill its ultimate objectives. These inputs can be provided in the framework of a third phase of the UNDP - Government of Barbados Project or in the framework of bilateral cooperation with an industrialized country.

A N N E X 1

VISITS MADE BY THE METROLOGY ADVISER TO FACTORIES, GOVERNMENT DEPARTMENTS AND PUBLIC UTILITIES

1. Buckleys Sugar Factory
2. Four S uare Sugar Factory
3. Lower Estate Sugar Factory
4. Sugar Technology Research Unit
5. Barbados Foundry
6. Roberts Manufacturing Co.
7. Banks B'dos Breweries Ltd.
8. Barbados Light & Power Co.
9. Natural Gas Corporation
10. Superintendant of Markets
11. Weights and Measures Branch
12. Pine Hill Dairy
13. Waterworks Department
14. Boilers Inspectors
15. West Indian Rum Refinery
16. Intel Barbados
17. Applied Magnetics
18. VRN Electronic Components
19. Island Enterprises (sandpit)
20. Flour Mill

A N N E X 2(a)

METROLOGY EQUIPMENT FOR BNSI

Item No.	Quant.	Description and Specifications	Manufact. & Model
		I. Mass Measurement	
		A - Masses	
P.1	1	Set of masses 1 mg to 20 kg, stainless steel with NPL Calibration certificate* (Primary Standard Set)	Oertling
I.1	1	Set of masses 1 mg to 20 kg, chromeplated brass, accuracy class F_1 + (Secondary Standard Set)	Reverifications
P.2	1	Set of masses 1 mg to 20 kg, chromeplated brass* (Working Standard Set)	Reverifications
P3-5	3	Sets of masses 1 mg to 20 kg, brass* (Standards for Inspectors of Weights and Measures)	Reverifications
		B - Balances	
P.9	1	Microbalance 20 g, d=0,001 mg*	Oertling
I.2	1	Semi microbalance 200 g, d=0,01 mg	Mettler H54AR Special
I.3	1	Analytical balance 1000 g d=0,1 mg	Mettler 315H
P.7	1	Equal-arm balance 5 kg, d= 10 mg*	Reverifications
P.6	1	Equal-arm balance 25 kg, d=25 mg	Reverifications
P.	1	Platform balance 120 kg, d=1 g*	Avery, modified at BNSI

* Delivered in Phase I of the Project

\+ Ordered but not delivered till the date of writing of this report

A N N E X 2(a) Cont'd

Item No.	Quant.	Description and Specifications	Manufact. Model
		II. Length Measurement A - End Standards and Instruments	
P.23	1	Set of gage blocks up to 50 mm*	Mauser
P.132	1	Gage block 60 mm*	"
I.9	1	Set of three gage blocks, 100, 200, 300 mm	Hommelwerke
I.10	1	Gage block accessories+	Zeiss, Jena
I.11	1	Precision indicator d=0,001 mm with universal measuring setup+	Feinmess, Suhl 3815 and 3875
P.21-22	2	Micrometers 0-15 mm, d=0,01 mm*	Mauser
P.108-109	2	Micrometers 0-25 mm, d=0,01 mm*	NSK, Japan
P.98-99	2	Dial indicators 0-10 mm d=0,01 mm*	Peacock
P.107	1	Dial indicator 0-10 mm, d=0,01 mm*	Baty
P.18-20	3	Vernier height gauges 0-300 mm, d=0,02 mm*	Chesterman
P.104-105	2	Vernier callipers 0-150 mm, d=0,05 mm*	EB, Germany
P.106	1	Depth gage 0-300 mm*	Chesterman
I.12	1	Set of 23 measuring wires for metric threads+	Zeiss, Jena
I.13	1	Set of 28 measuring wires for Whitework threads+	" "
P.172	1	Optical flaf*	Mitutoyo
P.173	1	Set of optical parallels for checking micrometers*	"
P.168	1	Spirit level 150 mm, d=0,02 mm/m*	Omiseika

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ANNEX 2(a) Cont'd

Item No.	Quant.	Description and Specification	Manufact. Model
		II. Length Measurement	
		A-End Standards and Instruments	
P.169	1	Precision straight edge 500 mm*	Omiseika
P.170	1	Precision square 150 mm x 105 mm*	"
II. 1-2	1	Granite surface plate 1000 mm x 630 mm with accessories+	Johansson
		B - Line Standards and Instruments	
P.15	1	Length measuring machine 1 m, d=0,002 mm*	Heidenhain
P.35	1	Set of linear scales with optical readouts 2 x 100 mm & 2 x 1 000 mm*	"
P.24-29	6	Steel tapes 101 cm*	Chesterman
P.30-34	5	Steel tapes 20 m*	Garcia
P.186	1	Metric rule 1 m divided each mm with calibration certificate*	Japan
		III Volume Measurement	
P.13-14	2	Sets of pipettes 1 to 25 mL*	Griffin & George
P.11-12	2	Sets of glass cylinders 10 ML to 1 000 mL in case*	Reverification
P.10	1	Set of volume standards 2, 5, 10 and 20 L* (to be used for non-drinkable liquids)	Wragg Bros, (Visigage)
I.4	1	Set of volume standards 2, 5, 10 and 20 L+ (to be used for drinkable Liquids)	"

* Delivered in Phase I of this Project

\+ Ordered but not delivered till the date of writing of this report

ANNEX 2(a) Cont'd

Item No.	Quant.	Description and Specification	Manufact. Model
		IV. Force and Hardness Measurement	
II.4	1	Set of tension-compression dynometers 2,5 - 10 - 40 KN with mech. indicator+	Kraftmessgerate Halle, KMBM
II.3	1	Rockwell hardness tester+	Nakai, 3R
P-128	1	Tensile testing machine 250 kgf*	
		V. Pressure Measurement	
I.14	1	Piston and weight manometer tester for pressure and vacuum -1 to +1 bar+	Budenberg 240 L
P.92	1	Piston and weight manometer tester from .10 - 2 000 lb/in^2*	Budenberg 280 L
I.15	1	Precision U-tube manometer 800 mm+	-
		VI. Density Measurement	
I.5	1	Set of 24 precision hydrometers from 0,800 to 2 000 reading to 0,002	Baird and Tatlocks 242/742
I.6	1	Set of 7 API Thermohydrometers from 9 to 81° API	Fisher 11-603-5
I.7	1	Set of 3 Brix hydrometers from 0-35 Brix	Fisher, (11-608/610)
1.8	2	Precision alcoholometers 0-100% alcohol by volume	Baird & Tatlock 242/1100
II.16	1	Set of II Alcohol hydrometers 780 to 1 000 kg/m^3 Class I according to EEC	Astell lab. Serv.

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A N N E X 2(a) Cont'd

Item No.	Quant.	Description and Specifications	Manufact. Model.
		V11. Temperature Measurement	
II.5	2	Sets of precision standard thermometers with calibration certificate - 20 to 202°C	Negretti and Zambra
II.6	1	Set of two ASTM certified thermometers +195° to 405°C	SGA,T-3800
I.17	1	Thermometer calibration bath with stirrer and heater up to +600°C	Boepple
I.18	1	Refrigerated bath -10 to 100°C	Haake, D3G
I.19	1	Ice Point cell	Mectron, Zeref
P.161	1	Thermocouple potentioneter*	Croydon Inst.
P.162	1	Chronel - alumel thermocouple*	Pyrotenox
P.163	1	Platinum/Platinum - 10% Rhodium thermocouple*	Croydon Inst.
P.164	1	Copper const. thermocouple*	Croydon Inst.
P.147	1	Electrical thermometer*	Tempkey
I.20	1	Set of 4 faden thermometers from 0-200°C length of bulb 50, 100, 150 and 200 mm+	-
		V111. Electrical Measurement	
P.135	2	Twin standard cells with calibration certificate*	Muirhead
I.21	1	Universal compensator - potentiometer for calibration of DC voltage to 1000V, current to 5,5 A resistance from 10^{-5} to 10^{7} Ohm	Messtechnik Mellenbach KMT 4
I.22	1	D C Supply 60V, 15A	Hewlett Packard Mod 6439B

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ANNEX 2(a) Cont'd

Item No.	Quant.	Description and Specifications	Manufact. Model
		VIII. Electrical Measurement Cont'd	
P.202	1	Digital multimeter*	Solartron, 7045
I.25	1	AC/DC pointer ammeter 0-6A, class 0,2	Hartman and Braun, ELFPA
I.26	1	AC/DC pointer wattmeter 2,5 & 5A 3-300V, class 0,2	Hartmann and Braun, ELGP
I.27	1	Precision current +transformer class 0,05 10-25-50-100 A/1A+	Tettex, 4730 Spec.
II.14	1	Cosphimeter Class 1,5+	Goerz, 524791
II.15	1	Absolute current source+	Optimation, CS-110
II.11	1	Set of standard resistors in can 1,10,100 Ohm and 1,10,100 K Ohm with calibration certificate+	Leeds and Northrup
P.165	1	Resistance box 10-100 000 Ohm 0,01%*	Jay Instr.
P.148	1	Decade resist. box (1 x 10 1 MOhm x 10)*	Sigma Electric
P.166	1	Resist. box 1 x 10, 10 x 10, 100 x 10, 1 K Ohm x 10, 10 K Ohm x 10*	Lloyd Instr.
P.181	1	Universal bridge for R - C - L	Marconi TF 2700
P.176	1	Wide range oscillator*	Marconi TF 2103
P.139	1	Dual trace oscilloscope*	Marconi
P.182	1	Regavolt variable transformer 300 V,0-15 A*	

* Delivered in Phase I of the Project

\+ Ordered but not delivered till the date of writing of this report

A N N E X 2(a) Cont'd

Item No.	Quant.	Description and Specifications	Manufact. Model
		1X. Time and Frequency Measurement	
P.188	1	Universal counter - timer*	S.E Labs, SM 202M
P.73	1	Stop-watch 0 - 30 min*	
P.74	1	Stop-watch 0 - 15 min*	
P.74	1	Stop-clock 0 - 60 min*	
		X. General	
I.29,P.93	2	Thermohygrograph	Fischer
I.30	1	Assman type aspiration psychrometer+	-
I.31	20	Body thermometers 15 - 30°C, div 0,2°C+	Zeiss Jena
II.17	1	Programmable calculator with magnetic cards+	Texas Instr. TI - 59

* Delivered in Phase I of the Project

+ Ordered but not delivered till the date of writing of this report.

A N N E X 2(b)

Equipment List III

(Metrology Equipment eventually needed by BNSI but for which no financing was available by the end of Phase II of the Project)

Item No.	Quant.	Description, Specification & Model	Estimated Cost U S $
II.1	50	20-kg cast iron masses, epoxy painted Avery	2 000
III.2	30	500-kg cast iron masses, epoxy painted Avery	45 000
III.3	1	Platform balance with drop weight cabinet 500 kg, scale interval 10 g (by Berliner Industriewaagen, West Berlin	15 000
III.4	1	Universal testing machine 25 KN Instron model 1123 - USA)	30 000
III.5	1	Standard Platinum resistance thermometer with calibration certificate (tinsley - UK)	2 500
III.6	1	Triple point cell (Spembly - UK)	600
III.7	1	Thermocouple calibration furnace to 1 000°C (Leeds and Northrup 09009 with accessories)	3 300
III.8	1	Precision capacitance measuring system (General Radio 1621 - BN - USA)	10 000
III.9	1	Set of standard air capacitors 0,01 to 1 000 p F(Gen Rad. 1403 - USA)	1 300
III.10	1	Set of standard capacitors 10 to 1 000 pF, 0,01 - 0,1 - 1,0 µF (Genrad 1404 & 1409)	1 500

A N N E X 2(b) Cont'd

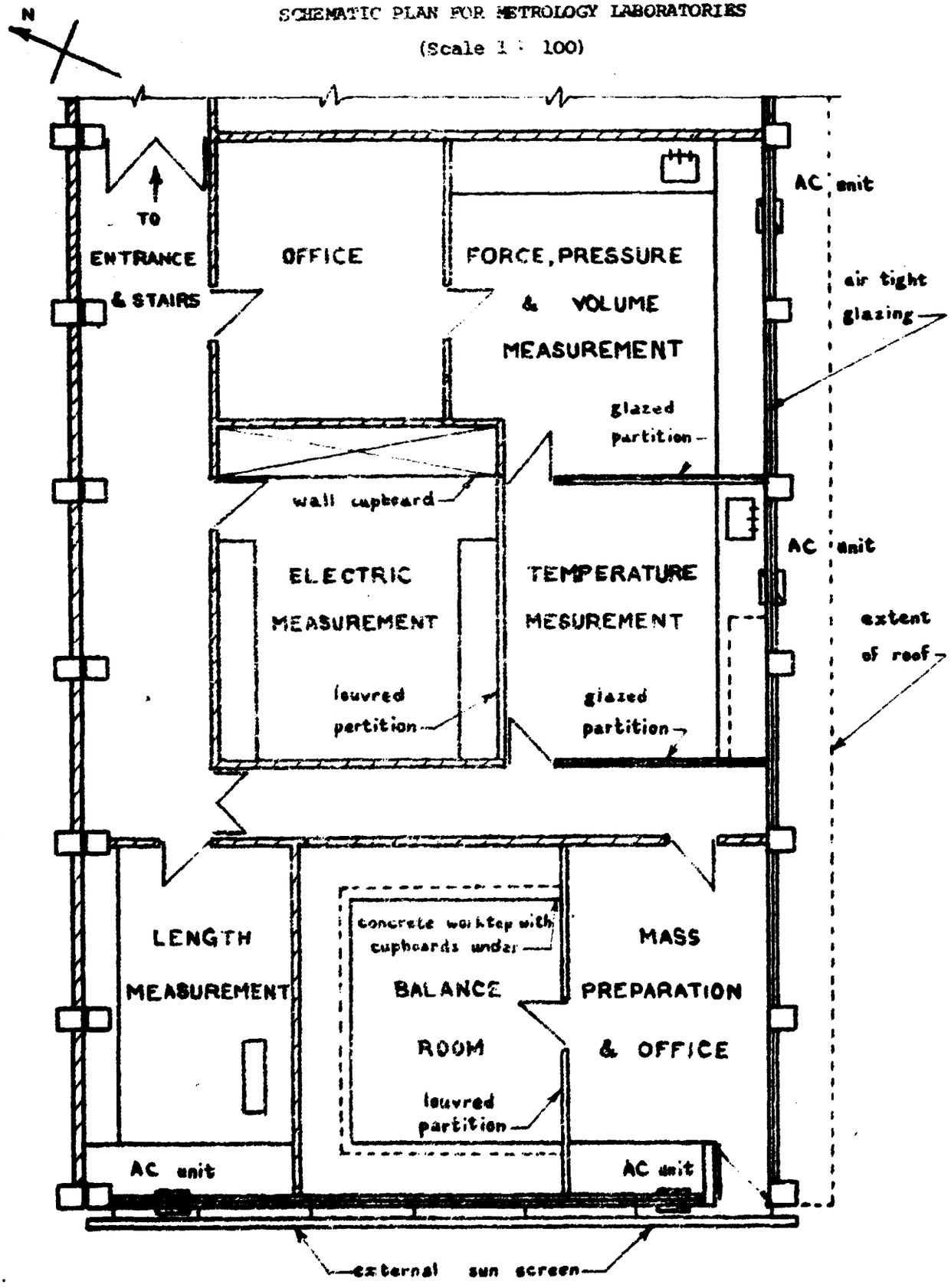
Equipment List III

Item No.	Quant.	Description, Specification & Model	Estimated Cost U S $
III.11	1	Variable precision capacitor 25-105 pF, 100-1050 pF (Genrad 1422 DP)	1 500
III.12	1	Precision inductance measuring assembly (Genrad 1660 A)	4 000
III.13	1	Set of standard inductors 100 µH, 1, 10, 100 mH, 1, 10 H (Genrad 1482)	3 000
III.14	1	Set "Q" standards (Hewlett Packard (5)00518A and 00513A)	900
III.15	1	Standard cell enclosure((Guild line 9154)	2 000
III.16	1	Equal-arm balance 5 kg, sensitivity 5 mg (reverifications) (To replace item p.7 which will be used for control of commercial masses)	1 500
		TOTAL	124 100

ANNEX 3

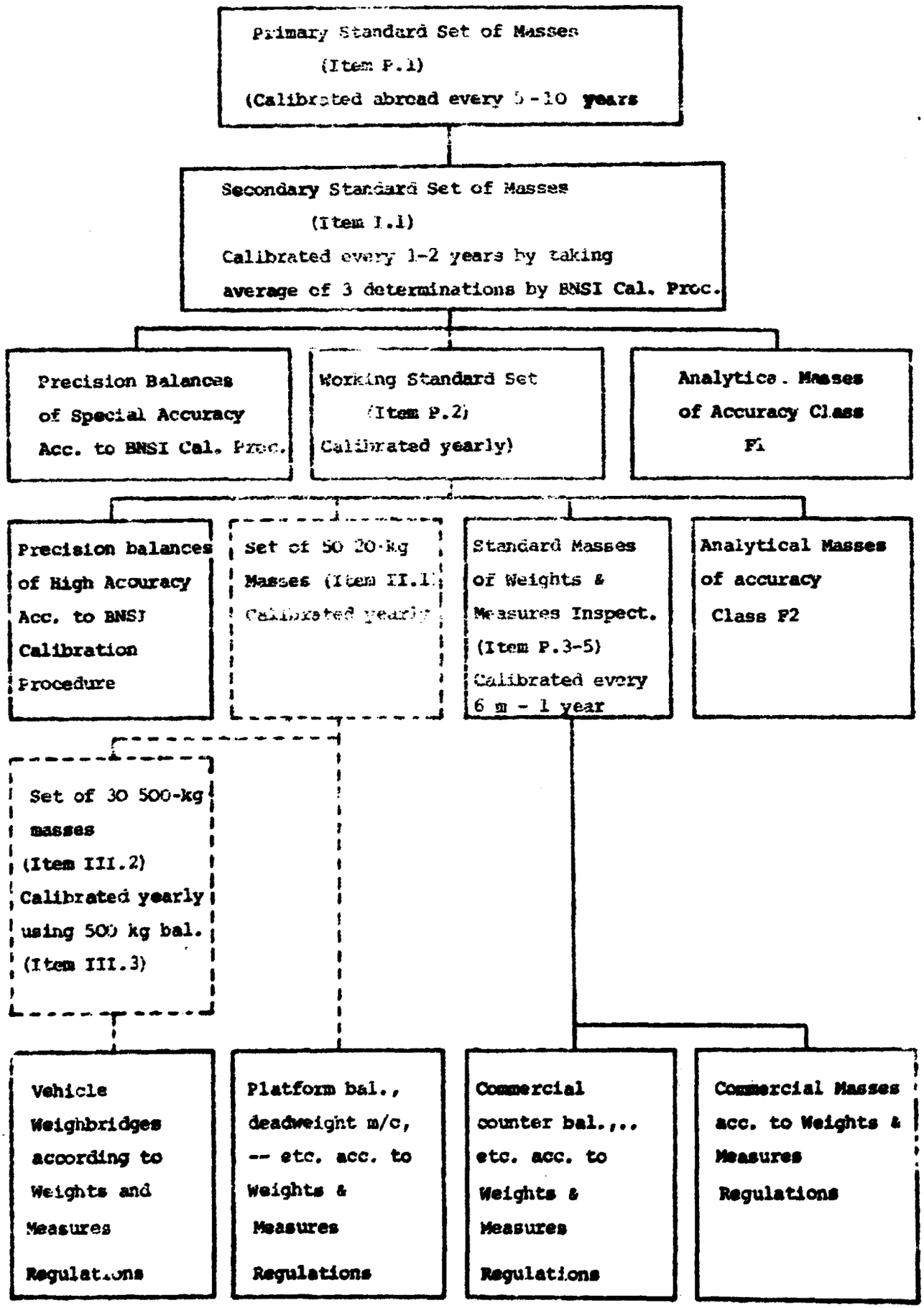
SCHEMATIC PLAN FOR METROLOGY LABORATORIES

(Scale 1 : 100)



A N N E X 4(3)

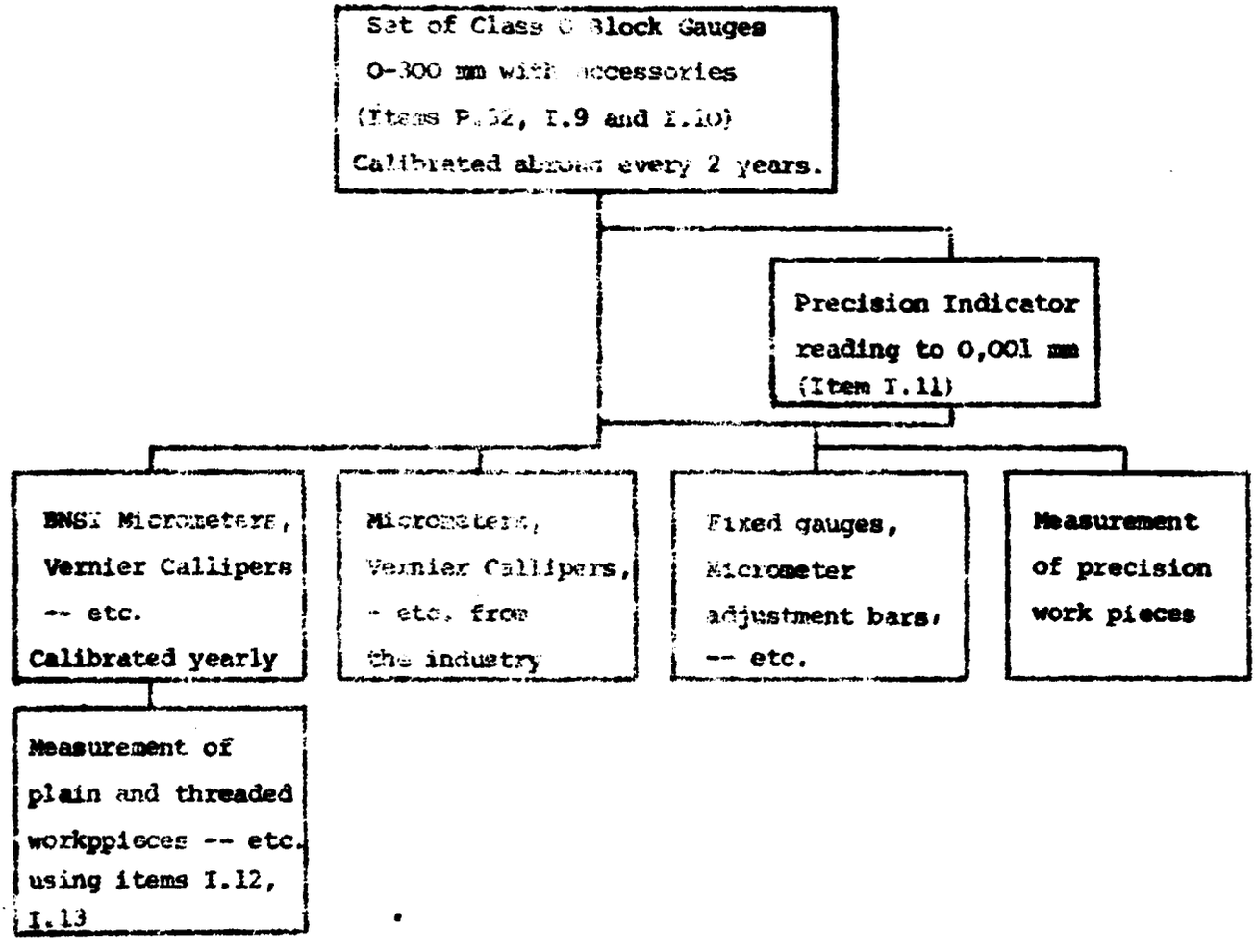
CALIBRATION SCHEME FOR MASS



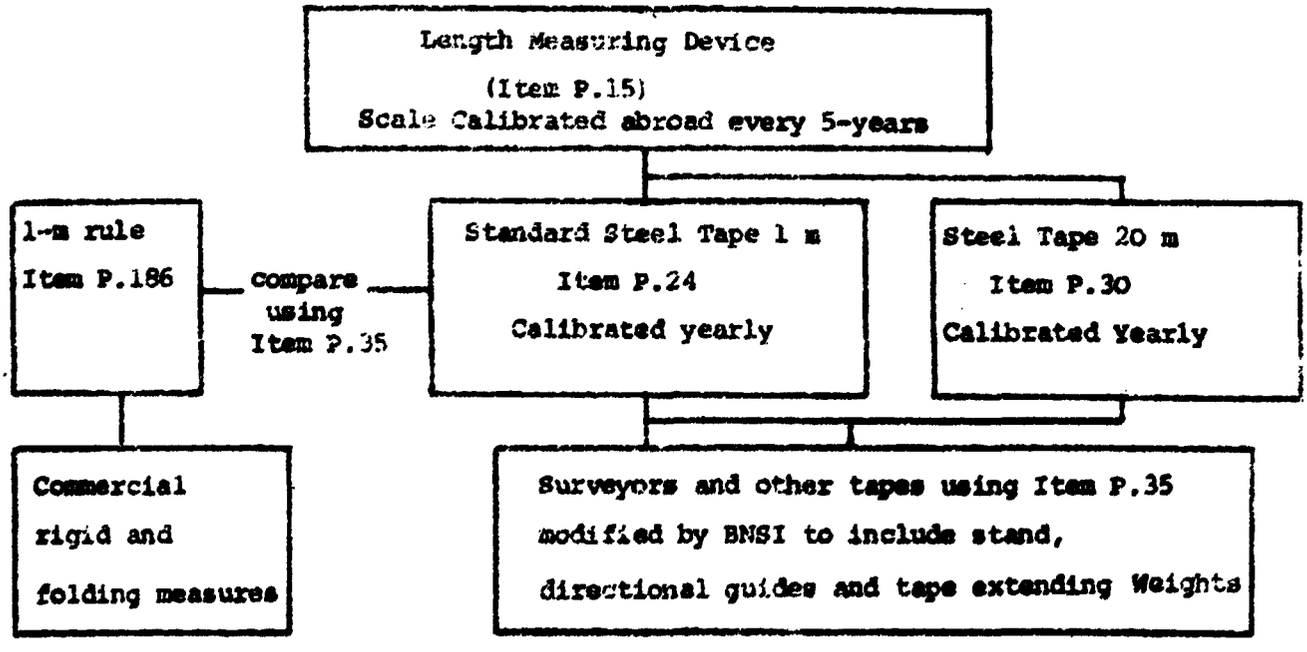
ANNEX 4(b)

CALIBRATION SCHEME FOR LENGTH

I. END STANDARDS AND MEASURES



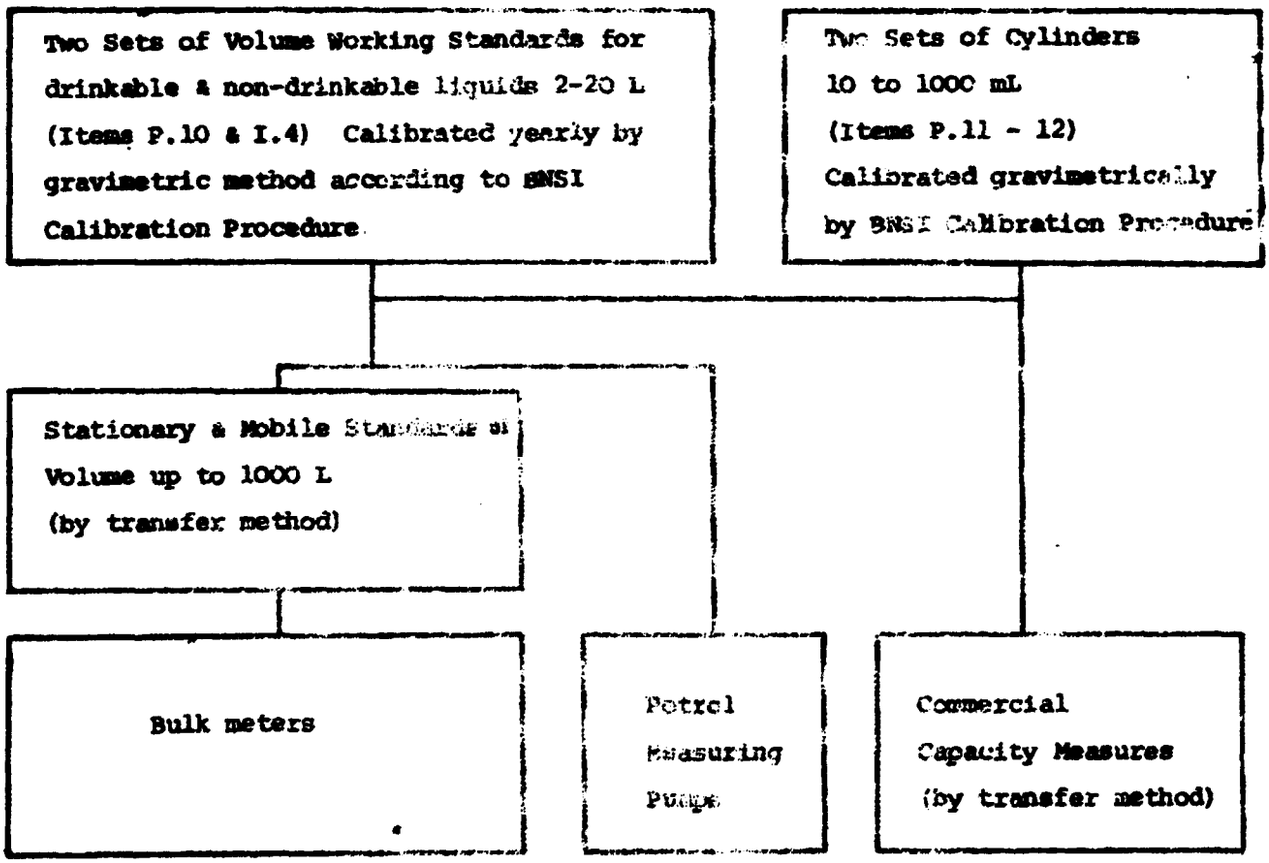
II. LINE STANDARDS & MEASURES



ANNEX 4(c)

CALIBRATION SCHEME FOR VOLUME

I. METALLIC STANDARDS AND MEASURES

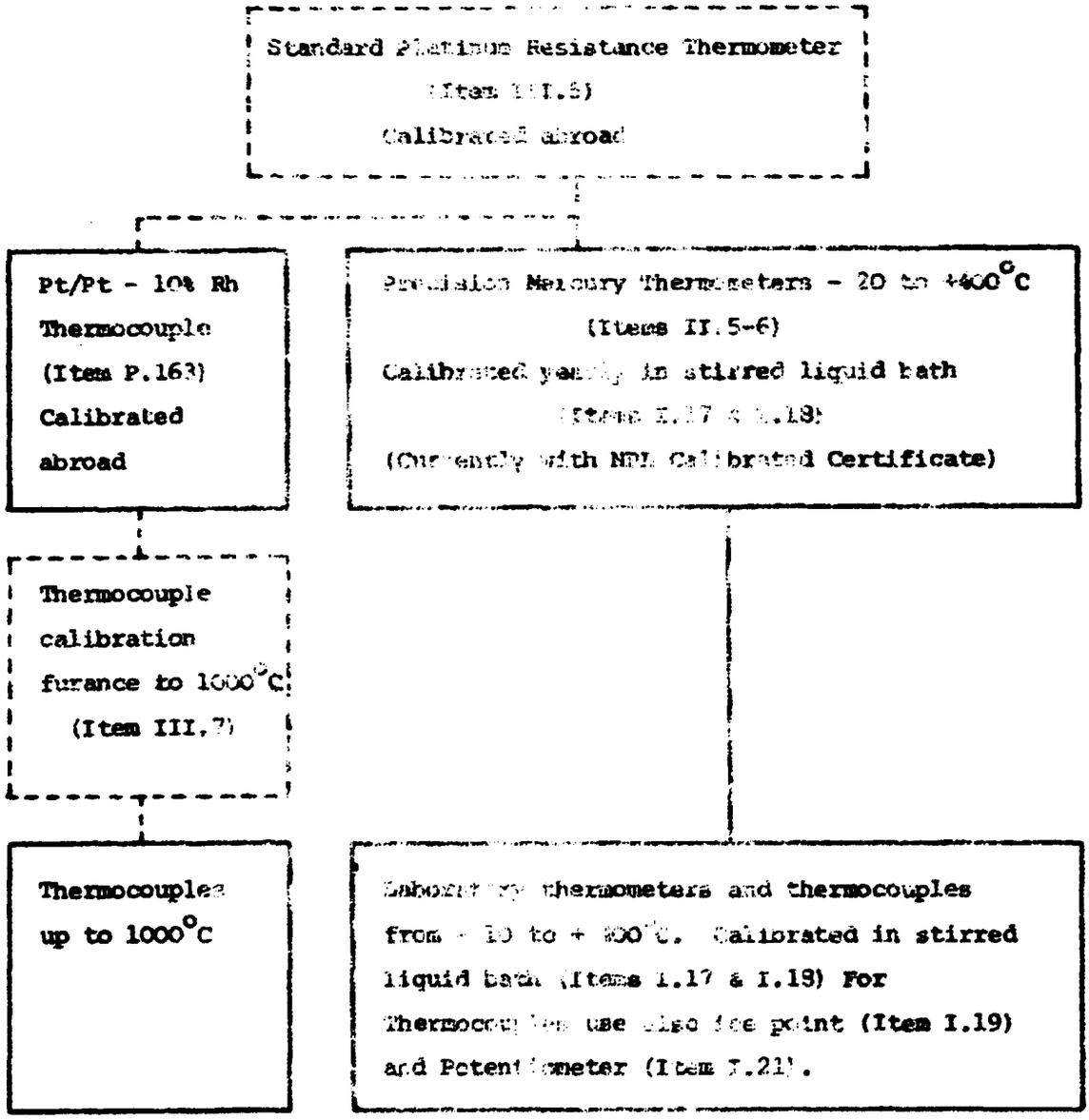


II. GLASS STANDARDS AND MEASURES

Calibrated by gravimetric method.

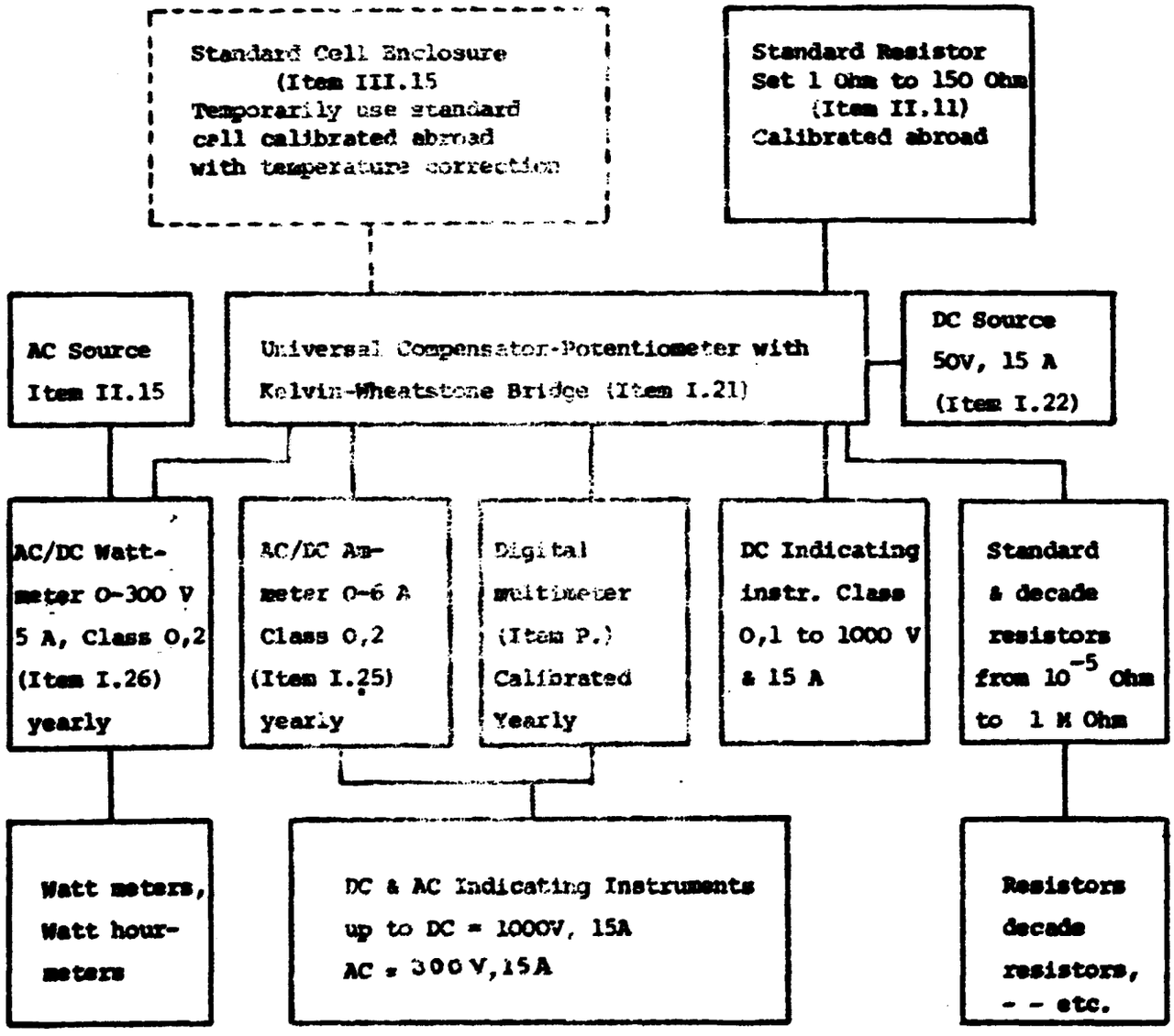
ANNEX 4(i)

CALIBRATION SCHEME FOR TEMPERATURE



ANNEX 4(e)

CALIBRATION SCHEME FOR ELECTRICITY



A N N E X 5

Recommended Calibration Procedures for Standards and Instruments*

Standard or Instrument	Calibration Procedure (Publisher : No : Year - Title)
Standards of Mass	BNSI : 1980 - Calibration Procedure for standards of Mass.
Precision Balances	BNSI : 1980 - Calibration Procedure for Precision Balances.
Metallic volume standard	BNSI : 1980 - Calibration Procedure for Volume Standards.
Volumetric glassware	NBS : IR461 : 1974 - Calibration of Small Volumetric Laboratory Glassware. (For calculations refer also to BNSI Calibration Procedure for volume standards).
Micrometers	BS : 864 : 1978 - External Micrometers.
Pressure and Vacuum gauges	OIML : R17 : 1970 - Indicating manometers, manovacuometers and vacuometers. (For use of dead weight testers refer also to manufacturer's instruction and BS 1780 Part 2 : 1971).
Tensile testing machine	ISO : R147 : 1960 - Load Calibration of Tensile Testing Machines.
Liquid-in-glass thermometers	NBS : Monogr. 150 : 1976 - Liquid-in-glass thermometry.
Thermocouples	NBS : Circ. 590 : 1958 - Thermo-electric thermometry.
Electric indicating instruments	BS : 89 : 1977 - Direct acting indicating electrical measuring instruments and their accessories.

* For methods of calibration of commercial measuring devices refer to the relevant Weights and Measures Regulations - Barbados.

A N N E X 6(a)

OUTLINE OF TRAINING COURSE

GENERAL METROLOGY

HELD IN BNSI AUGUST - SEPTEMBER 1979

1. Introduction and Basic Concepts (4 hrs.)

   - What is metrology?
   - Development of measurements
   - Modern measurement standards - Hierearchy of standards

2. Quantities and Units of Measurement (4 hrs)

   - Measurable quantities, value of a quantity
   - System of quantities, base and derived quantities
   - Base and derived units, coherent units
   - Dimensional analysis of formulae

3. Measures and Measuring Instruments (10 hrs)

   - Definition of measures and measuring instruments
   - Structure and block diagrams of measuring instruments
   - Metrological properties of measures and measuring instruments

     * Maximum and minimum capacity, measuring range
     * Sensitivity, linearity
     * Scale division, scale interval, digital interval
     * Discrimination, threashold of discrimination, passivity
     * Hysteresis
     * Response time
     * Repeatability, reproducibility
     * Bias
     * Inaccuracy, accuracy class
     * Constancy

A N N E X 6(a) Cont'd

4. Theory of Errors (24 hrs)

- Definition of errors
- Sources of errors

  * Instrument (design errors, manufacturing errors, adjustment errors, errors due to age and use).
  * Operator (improper use, negligence, bias, reading errors)
  * Ambient conditions (temperature, pressure, humidity, stray fields).

- Combination of errors, limiting errors
- Classification of errors according to probability (Systematic and random errors, blunders)

  * Systematic errors
  * Probability distribution of random errors, confidence limits
  * Combination of probable errors
  * Distribution of arithmetic mean
  * Total probable error

- Rounding of measurement results

5. International Cooperation in Metrology (4 hrs)

- Metre Convention and the International Weights and Measures Organization.
- International Organization for Legal Metrology.

6. Discussions and Presentations by Participants (34 hrs)

A N N E X 6(b)

OUTLINE OF TRAINING COURSE

"ASSESSMENT OF ALCOHOLIC STRENGTH IN LIQUORS"

"AND METRICATION OF ALCOHOLIC DUTIES"

HELD IN BNSI - FEBRUARY 1980

1. Definitions of alcoholic strength of liquors
2. Systems for assessment of alcoholic strength
3. Practical methods of measurement of alcoholic strength
4. Determination of alcoholic duties
5. Metrication of alcoholic duties
6. Instruments and tables needed for the implemantation of the metric OIML system.
7. Changeover to the metric OIML system
8. Examples of calculations of alcoholic quantities and duties in the metric OIML system and during the transitional period:
   - Conversion factors
   - Degrees of accuracy
   - Rounding rules
   - Examples of account in vat
   - Examples of account in cask assessed by weighing
   - Examples of quantity of alcohol in bottled spirits
   - Examples of use of the conversion factor

1980-07-18

AE1-T/mah