NBSIR 80-2022

NBS/AID Course on Weights and Measures Services

Edited by:
H. Steffen Peiser
Charles C. Raley
Albert D. Tholen
Penelope M. Odar

Office of International Relations
National Bureau of Standards
U.S. Department of Commerce
Washington, D.C. 20234

Held July 15-27, 1979

Issued April 1980

Prepared for

Agency for International Development
Department of State
Washington, D.C. 20523

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U.S. DEPARTMENT OF COMMERCE, Philip M. Klutznick, *Secretary*

Luther H. Hodges, Jr., *Deputy Secretary*
Jordan J. Baruch, *Assistant Secretary for Productivity, Technology, and Innovation*

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

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INTRODUCTION

On behalf of the National Bureau of Standards (NBS) and the Agency for International Development (AID), we present this report on the conduct in July 1979 of the second experimental two-week "Course on Weights and Measures Services," as they are practiced in the United States of America. Participants were intended to be, and were for the most part, heads or senior technical staff members of weights and measures agencies in their own countries. AID fund support for participation in the course was used primarily to pay the expenses of suitable candidates, who had been sponsored by USAID Missions in less developed countries.

The purpose of the course was to show by illustrative visits, lectures, and laboratory demonstrations how weights and measures systems operate in the United States. No country would wish to imitate these systems as practiced in the United States, but an awareness of the problems and methods was previously shown to be helpful for technical leaders in rapidly developing economies (compare, for example, NBS Interagency Report 79-1721 on the first NBS/AID Course on Weights and Measures Services). A second purpose of the course was to make it possible for the participants who came from Africa (5 countries), Asia (3 countries), and America (2 countries) to share with one another and us in the United States knowledge on how they solve problems and how they view the needs and opportunities for weights and measures services in their own countries.

This second purpose was fulfilled by papers on selected relevant topics being presented by the participants themselves. These papers are reproduced in this report in full and in alphabetic order by the name of the country. Although each participant had the opportunity to obtain consent for the text of his paper from his home agency, these papers should be regarded as informal, personal statements of views on problems and challenges, and by no means as official governmentally endorsed documents.

The U.S. systems of weights and measures can be looked upon from the following viewpoints:

(1) How local government assures equity and uniformity in retail markets.

(2) How a modern company assures itself of measurement control for raw materials, production processes, and quality of products.

(3) How an instrument manufacturing company ensures itself of credibility for traceable calibration and the stability and reliability which it claims for its products.

(4) How a professional technical society provides a forum for discussion of research and development in measurement methodology and applications.

(5) How the U.S. National Conference on Weights and Measures (NCWM) provides a forum of discussion leading to a consensus among agencies, enforcing the laws for assuring equity and uniformity in retail markets, the instrument industry, the trading public, and the U.S. National Bureau of Standards which disseminates the technical state of the art in measurement science and technology.

The first of these viewpoints was effectively imparted to the course participants by the visit to the Department of Weights and Measures of the County of Los Angeles, California (see p. 11). This was a most memorable visit for the excellence of the technical facility and the competence of the staff, as well as for the personal contacts made by the participants.

The second viewpoint was illustrated during the equally outstanding visit to the metrology laboratory of Rockwell International (see p. 14). This firm opened the doors of its metrology laboratories where the group was introduced to measurement techniques and administration that rank among the very best.

The third viewpoint was represented to the course participants by the visit to the John Fluke Manufacturing Company, whose electrical instruments are found in all parts of the world where electrical measurements of very high accuracy and precision are required.

The fourth viewpoint was demonstrated by a brief visit to the headquarters of the Society of Photo-Optical Instrumentation Engineers where the course participants were given an insight into the highly specialized publication and conference program of this Society.

The fifth and last viewpoint was most effectively achieved by the attendance of all members of the course at the annual meeting of the National Conference on Weights and Measures. Although this conference has in its title the word "national," for many years the NCWM has hosted interested specialists from abroad with a special warmth of welcome. The course participants, in addition to being welcome at all meetings of the NCWM in which they had an interest, were given a special lecture program (see p. 10) to suit their needs. The talks on the functions of the NBS included an evening discourse on weights and measures laws. This paper is reproduced in full in the report (see 63).

The course ended with an evaluation session (p. 67) where participants were able to give us the benefit of their views on the effectiveness and desirability for regularly held courses on weights and measures. Written evaluations were offered on a questionnaire which, with a summary of the responses, is reproduced in this report (p. 71).

This introduction could hardly acknowledge all the many contributors who have notably assisted us in the preparation and execution of this course. Outstanding efforts deserving our special gratitude were made by the following:

Mr. and Mrs. W. Mossberg, Mr. N. Gluck, and their colleagues at the Los Angeles Department of Weights and Measures; Mr. J. Driver, Mr. G. Rice, Mr. R. Vavken, Mr. R. Couture, and their colleagues at Rockwell International; Mr. E. Heineman, Ms. C. Lien, Messrs. Agy, Dellenbach, and Huntley and their colleagues at John Fluke Manufacturing Company; Mr. J. Yaver, Ms. Lundquist, Mr. and Mrs. Barrett, and their colleagues at the Society of Photo-Optical Instrumentation Engineers and the Western Washington College; and the organizers and speakers at the 64th National Conference on Weights and Measures.

H. Steffen Peiser
Chief
Office of International Relations

Albert D. Tholen
Chief
Office of Weights and Measures

October 18, 1980

PHOTOGRAPH IDENTIFICATION

From left to right:

1. Mr. G. Rivera
2. Mr. K. Kollie
3. Mr. J. Basurto
4. Mr. Y. Balogun
5. Mr. S. Peiser
6. Mr. W. Pratoommas
7. Mr. C. Raley
8. Mr. A. Gunawardena
9. Mr. Agy (Fluke Mfg. Co.)
10. Mr. B. Hassan
11. Mr. Huntley (Fluke Mfg. Co.)
12. Dr. D. Sen
13. Dr. M. Ammar
14. Mr. Dellenbach (Fluke Mfg. Co.)
15. Mr. M. Ben Larbi

(Photograph courtesy of John Fluke Manufacturing Company)

Participants

NBS/AID TRAINING COURSE ON WEIGHTS AND MEASURES SERVICES

July 15-27, 1979

(alphabetical by country)

Dr. Mohammed M. Ammar
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and Standardization
General Direction of Industry
Ministry of Economy
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Eng. Mohieddine Ben Larbi
Chief, Food Products Section
Laboratoire Central
Montfleury, Rue Dr. Braquehaye
Tunis, Tunisia

A G E N D A

National Bureau of Standards
Agency for International Development
TRAINING COURSE ON WEIGHTS AND MEASURES SERVICES

July 15-27, 1979

July 15, Sunday

AM - PM — Arrive Los Angeles, California, U.S.A.

8:00 PM — Opening Dinner

July 16, Monday

8:30 AM - 4:30 PM — Los Angeles Department of Weights and Measures
11012 Garfield Avenue
South Gate, CA 90280
(213) 922-8916

Host: Mr. W. Mossberg, Director

July 17, Tuesday

8:00 AM - 4:30 PM — Los Angeles Department of Weights and Measures

July 18, Wednesday

7:30 AM - 4:00 PM — Rockwell International
Autonetics Marine Systems Division
3370 Miraloma Avenue
Anaheim, CA 92803
(714) 632-2685

Host: Mr. G. O. Rice
Manager, Metrology and Test Equipment

6:30 PM - 9:00 PM — Dinner Meeting

July 19, Thursday

7:30 AM - 4:00 PM — Rockwell International

July 20, Friday

8:30 AM - 3:30 PM
John Fluke Manufacturing Co.
P.O. Box 43210
Mountlake Terrace, WA 98043
(206) 774-2211

Host: Mr. E. Hineman, Export Sales Manager

5:00 PM - 10:00 PM
Society of Photo-Optical Instrumentation Engineers
P.O. Box 10
Bellingham, WA 98225
(206) 676-3290

Host: Mr. Joseph Yaver, Executive Director

July 21, Saturday

AM - PM
Free

July 22, Sunday

6:00 PM
Conference Reception
National Conference on Weights and Measures

July 23-27, Monday-Friday

AM - PM
64th National Conference on Weights and Measures

(See supplementary program on next page)

SUPPLEMENTARY PROGRAM
for
COURSE PARTICIPANTS
PRESENTED BY
NBS STAFF
at the

NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

July 23-27, 1979

1. "Weights and Measures in the U.S.A.," Mr. R. N. Smith, Office of Weights and Measures, NBS

2. "Standards and Laboratories," Mr. B. Keysar, Office of Weights and Measures, NBS

3. "Measurement Engineering Projects," Mr. S. Hasko, Office of Weights and Measures, NBS

4. "U.S. Participation in the International Organization for Legal Metrology (OIML)," Mr. D. E. Edgerly, Chief, Office of Domestic and International Measurement Standards, NBS

5. "Legal Aspects of Weights and Measures," Mr. A. J. Farrar, Legal Adviser, NBS (Dinner Meeting)

6. "Measurement Sciences Challenges," Dr. C. B. Brickenkamp, Office of Weights and Measures, NBS

7. "Prototype Examination," Mr. H. Opperman, Office of Weights and Measures, NBS

8. Summary and Evaluation Seminar, Mr. H. S. Peiser, Chief, Office of International Relations, NBS (Breakfast Meeting)

(NCWM Program available from:

National Bureau of Standards
Office of Weights and Measures
Washington, D.C. 20234

(DETAILED AGENDA)

COUNTY OF LOS ANGELES
DEPARTMENT OF WEIGHTS AND MEASURES
11012 GARFIELD AVENUE
SOUTH GATE CALIFORNIA 90280
TELEPHONE (213) 922-8916

W. R. MOSSBERG
DIRECTOR

NAHAN H. GLUCK
ASSISTANT DIRECTOR

TRAINING FOR FOREIGN WEIGHTS & MEASURES OFFICIALS

Purpose: To share our technology with other countries.

July 16, Monday

8:30 A.M.	Assembly Room - Room 144A Introduction by Director to the Department Staff and guests.
	Films - 1. A true standard (NBS) 2. Assignment Wts. & Meas. (NBS) 3. Video Tape - Rath Case
9:30 A.M.	Break
9:45 A.M.	Chronology of W & M in U.S. to present - traceability, laws, and county structure.
	Slide presentation on L.A. County activities.
10:15 A.M.	Metrology Lab discussion and tour of L.A. County facilities including vehicle scale and fast flow meter demonstrations.
11:30 A.M.	Lunch
12:30 P.M.	Assembly Room - Room 144A

Meter Division

1. Responsibilities
   - A. Meter section.
   - B. Metrology Laboratory
2. Variable Frequency Inspection.
3. Cost - benefit - impact.
4. Enforcement - disciplinary action criteria.
5. Registered Repairman.

1:25 P.M. Scale Division

1. Programs - work load - procedures.
2. Device repair program.
3. Cost - benefit - impact.
4. Statistics.
5. Enforcement - disciplinary action - citations.

2:20 P.M. Break

2:30 P.M. Quantity Control Division

1. Work locations.
2. Type of products.
3. Methods of tests.
4. Inspection results.
5. Disciplinary Action.
6. Statistics.
7. Demonstrations.

3:25 P.M. Investigation Division

1. Programs - procedures (meat audit - Mkt. Insp.)
2. Test purchases.
3. Delivery checks.
4. Petroleum and Weighmaster programs.
5. Citations - infractions - legal.
6. Demonstration.

4:30 P.M. Dismiss

July 17, Tuesday

8:00 A.M. Assembly Room 144A
Divide Field in-plant inspection schedule into two groups.

9:00 A.M. Group A

Arrive Ralphs retail market - Los Angeles
Point-of-Sale System - Electronic Scanner - U.P.C.

1. Market Inspection on site prepackaging of meat, fish, and poultry items.
2. Service Counter - test purchase procedure.
3. Check-out stand demonstration of U.P.C. Scanner System and its inspection.
4. Retail Q.C. demonstration.
   Disciplinary action procedures explained.

8:30 A.M. — Group B

Arrive Distribution Center or Processor to observe the inspection of prepackaged commodities at whole sale level.

A. Linge Bros. Coffee Co. - Commerce.
B. Safeway Bakery or Deli Plant - Commerce.
C. Certified Grocers - Commerce.

11:00 A.M. — Arrive - Board of Supervisors Hearing Room-(Both Groups - A & B) Observation
Local Government in Action - Introduction.

12:00 noon — Lunch

1:30 P.M. — Group A

Arrive - Distribution Center or Processor to observe the inspection of prepackaged commodities at wholesale level.

A. Fish King Processor (De-Glazing) - Los Angeles
B. Inter Polymer Ind. (Polyethylene)

1:30 P.M. — Group B

Arrive - Ralphs retail market - Los Angeles
Point-of-Sale - Electronic Scanner - U.P.C.

1. Market Inspection on site prepackaging of meat, fish, and poultry items.
2. Service Counter - test purchase procedure.
3. Check-out stand demonstration of U.P.C. Scanner System and its inspection.
4. Retail Q.C. demonstration. Disciplinary action procedures explained.

3:30 P.M. — Leave area.

4:00 P.M. — Regroup Assembly Room 144A.

Review

Farewell.....

AGENDA

ROCKWELL INTERNATIONAL METROLOGY SEMINAR
SPONSORED BY
U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

18 - 19 JULY 1979

Rockwell International

ROCKWELL INTERNATIONAL
ELECTRONIC SYSTEMS GROUP

AUTONETICS MARINE SYSTEMS DIVISION

James R. Driver	Director Production Operations
George O. Rice	Manager Metrology
Roland Vavken	Manager Metrology Operations
Robert J. Couture	Manager Metrology Engineering
James L. Arther	Metrologist
Laurie M. Baker	Metrologist
Jack A. Hall	Metrologist
Kenneth J. Lund	Metrologist
Thomas A. Samp	Metrologist

AGENDA

Wednesday, 18 July 1979

7:30	Orientation Tour of facilities not covered by technical sessions	
9:15	Break	
9:30	Technical Sessions:	
	A Inductance and Capacitance	T. A. Samp
	B Pressure	L. M. Baker
11:15	Luncheon - Griswold's Smorgasbord	
12:15	Technical Sessions:	
	A Magnetics	J. L. Arther
	B Length	K. J. Lund
2:00	Break	
2:15	Technical Sessions:	
	A Mass	L. H. Baker
	B Optics and Photometry	J. A. Hall
4:00	Adjourn	
6:30	Griswold's Hotel - Crystal Room B Attitude Adjustment	
7:00	Dinner	
8:00	Presentation: The Industrial Standards Laboratory	
	Introduction/Moderator	G. O. Rice
	Purpose and Development of Rockwell's Metrology Laboratory	
	Management Interface	J. R. Driver
	Metrology Engineering	R. J. Couture
	Metrology Operation & Controls	R. Vavken
	Questions & Answers	G. O. Rice
9:00	Adjourn	

Thursday, 19 July 1979

7:30	Technical Sessions:	
	B Inductance & Capacitance	T. A. Samp
	A Pressure	L. H. Baker
9:15	Break	
9:30	Technical Sessions:	
	B Magnetics	J. L. Arther
	A Length	K. J. Lund
11:15	Luncheon - Griswold's Smorgasbord	
12:15	Technical Sessions:	
	B Mass	L. H. Baker
	A Optics & Photometry	
2:00	Break	
2:15	Summary Session	
3:30	Depart for Airport	

COOPERATION BETWEEN SCIENTIFIC METROLOGY AND THE WEIGHTS AND MEASURES SERVICE IN EGYPT

by

Dr. Mohammed M. Ammar
Director, National Institute for Standards
Cairo, Egypt

Acknowledgment

It is a great pleasure to express my thanks and gratitude to the U.S. Agency for International Development, to the National Bureau of Standards, and to the Office of International Relations of NBS for giving me the opportunity to attend this Course on Weights and Measures Services and to discuss some of our problems and what we are doing about them.

Introduction

Measures play a very important role in our life and and decide about most of our acts which are counted, weighed, and measured. Measures make it possible on the national and international levels to engage in loyal and honest commercial exchanges and to assure everybody that what is due to him can be demonstrably given to him. Therefore, instruments and apparatus used in these operations should be controlled by the government which must teach metrology in all schools, impose a system of measures, make laws and regulations concerning the measures, and create an administration for their application and supervision.

Development of the SI System of Units

The science of measurement was revolutionized by the adoption in 1875 of the metric system, realized through definitions of constant standards and its growing use throughout the world. Although the metric system was primarily devised to benefit industry and commerce, it was also necessary to choose a convenient nomenclature for large multiples and submultiples of these units which benefit science and technology. The earliest standards adopted were the centimeter, gram, and second known as the C.G.S. system of units.

However, for industry and trade these units were rather small, and there was a growing use in metric countries of the meter, kilogram, and second. In 1900 the MKS system replaced the C.G.S. system of units.

In 1935 the International Electrotechnical Commission (IEC) recommended the addition of a fourth basic electrical unit, the ampere; this new system (MKSA system) in 1954 was adopted by the

General Conference on Weights and Measures as a basis for a practical system of units for international use, with the addition of three further base units: the kelvin for thermodynamic temperature, the candela for luminous intensity, and the mole for the amount of substance. The system was designated by the General Conference on Weights and Measures as the International System of Units (SI).

Functions and Obligations of a Weights and Measures Service

One of the major functions of a weights and measures service in a country is to disseminate the SI system of units by carrying out the following steps:

(1) To suppress the use of old units and old measuring devices.

(2) To formulate the regulations which are necessary to define the legal units and national standards of measurements and to consider the use of any other units as illegal.

(3) To consider that all sales or purchases, all public or private contracts using other units of measurement, are illegal.

(4) To make the teaching of the legal units compulsory in schools; they should be the only ones taught in primary schools.

(5) To prohibit for use every device or measuring instrument graduated in other units than the legal ones.

Besides these functions, a weights and measures service is responsible for:

(1) The approval of every device or measuring instrument intended for use in trade and to check regularly that all measuring instruments exhibited, sold, or used by the public as being of an officially admitted type and that they satisfy regulations issued concerning them.

(2) The regular control and verification of the constancy of their characteristics during use and after repair.

(3) The application of the laws and the analysis of the progress achieved and delays suffered in their application as well as of the exceptions that might be authorized.

Weights and Measures Service in the Arab Republic of Egypt

In Egypt the Weights and Measures Service is a responsibility of the Ministry of Supplies and Internal Trade. A central office is located in Cairo and 30 district offices are situated throughout the country. They have a total staff of about 100 inspectors. The Service controls

weights, weighing instruments, volume measures, length measures, petrol pumps, gas meters, and water meters.

The metric system is the only legal one, and regulations require initial verification and stamping of all instruments manufactured in Egypt. Transport is provided for inspection and on site testing of fixed equipment. The Weights and Measures Service also operates a workshop for the repair of Government-owned weighing instruments. Some facilities are made available to private users. Weights, length measures, volume measures, and weighing instruments which are locally manufactured are approved by the Service. The central office at Cairo maintains the standards used for calibrations. These standards are calibrated regularly by the National Institute for Standards.

Cooperation Between the National Institute for Standards and the Weights and Measures Service

a. Calibration of the primary standards:

In Egypt scientific metrology is the responsibility of the National Institute for Standards (NIS), which also keeps in its custody the legal national standards of measures. NIS provides to the Weights and Measures Service the periodic recalibration of its standards.

As was mentioned in a previous article,* it is uneconomic to establish such a high level institute as NIS in every country and a well-equipped institute is sufficient to serve the whole region. NIS in Cairo carries out calibration of the reference standards of length and weights of the different countries which are members of ASMO (Arab Organization for Standardization and Metrology).

b. Training:

NIS in Cairo provides training programs for different aspects of metrology and in the testing and calibration of standards for which the facilities of the Institute could be used.

In the CASTARAB Meeting held in Rabat, Morocco, in August 1976, it was stated:

"The National Institute for Standards in Cairo possesses excellent facilities for the purpose of training. It is therefore suggested that CASTARAB urge the Governments of the Arab states to give their active support to the organization of such courses on a regional basis."

In 1975 the National Institute for Standards submitted a request under UNESCO's Program for extending its service to training of

*Ammar, Mohammed M., "Metrological Services in the Arab Republic of Egypt," Report to AID on an NBS/AID Workshop on Standardization and Measurement Services, October 1-18, 1977, NBSIR 78-1712, p. 39.

personnel acting in the field of metrology on both national and regional levels.

Under this project, UNESCO was requested to assist in supplying the Institute with some equipment similar to the existing ones but of less precision. This is necessary to get the trainees acquainted with instrument handling before operating on the high-precision instruments, already existing.

UNESCO was also asked to supply other equipment needed to cover various fields of legal metrology, such as large masses, measures of volume for liquids and capacity for seeds, meters for domestic gas, etc. However, due to lack of funds, the project was postponed.

At the present time, the National Institute for Standards in collaboration with ASMO and the Faculty of Engineering, Alexandria University, is trying to carry out training on both the national and regional levels. The duration of the course may be one year.

The candidates must be graduates in engineering or science and working in the fields of industrial or legal metrology. The topics must cover different areas. The first area is a very general one and should include such subjects as the definitions of terms used in metrology, precision, accuracy, theory of errors and statistical treatment of data, the physics, and other subjects related to metrology, some general lectures on the overall function of a national weights and measures service, the international organizations with responsibilities in weights and measures, etc.

The second part includes the methods of testing the standards and equipment required by a weights and measures service to ensure the continued accuracy of its own testing, e.g., the calibration of standard weights using a reference set, the care and use of precision balances and methods of measuring their accuracy, etc.

The third part may include testing of the various types of weighing and measuring equipment which are likely to be subject to legal control. This part should include also the theory and construction of these equipments.

The Expected Cooperation Between the National Bureau of Standards and the National Institute for Standards

At the present time, a project proposal has been submitted to the United States Agency for International Development (AID) for cooperation with NBS in manpower development and transfer of measurement science and technology. The aim of this proposed project is to facilitate NIS:

(1) To acquire experience in the design and construction of specialized measuring apparatus.

(2) To utilize acquired knowledge and skills to transfer successfully appropriate measurement technology from the United States to Egypt.

(3) To acquire the capability for the selection, use, and maintenance of precision measuring instruments.

(4) To develop experience in adopting modern methods of metrology for upgrading existing basic standards and extending the range of their application.

(5) To develop appropriate means to disseminate efficiently and quickly the techniques of modern measurement science and technology to the appropriate domestic industrial and service sectors.

(6) To make appropriate plans for the effective use of available buildings for metrology.

It is certain that this project will strengthen NIS capabilities and extend its activities, to benefit both legal and industrial metrology in Egypt and in the other countries of the region.

MY PERSONAL OPINIONS ON THE NEED AND POTENTIAL FOR AN EFFECTIVE LAW ON WEIGHTS AND MEASUREMENTS*

by

Mr. Guillermo Enrique Rivera A.
Department of Engineering and Standardization
General Directorate of Industries
Ministry of Economy
Tegucigalpa, Honduras

For a complete report on the possibilities and potential of an effective law on weights and measurements in Honduras, many basic elements of judgment are necessary. Judgments should be based on some investigations including tests, opinion surveys, observations, experience, etc. However, in this report I will try to make general observations without strong back-up which is not yet fully available in Honduras.

Inconvenience Found in the Application of the Decimal Metric System

At the moment, Honduras does not have an effective law on weights and measurements; the legal support for metrological activities is the Legislative Decree No. 39 which was issued on May 11, 1895, with the legislative power vested in a National Constituent Assembly, and which came into force from February 22, 1897, with a By-Law which establishes the decimal metric system as the only measurement system in Honduras. However, in spite of the fact that for that time it was a very functional system, a series of difficulties prevented its application and acceptance because:

1. It was not foreseen that a national institution would be needed to provide basic metrological services.

2. A lack of equipment and laboratories makes the enforcement of the Law extremely difficult.

3. The influence of external markets in weight and measurement equipment with the Anglo-Saxon and antique Spanish systems.

4. Deficiencies in the transfer of technology.

5. Little development of the mass communications within the country.

6. Fiscal difficulties in the governmental administrative organization.

---

*The opinions expressed in this paper are the author's and in no way represent the official policy of the Government of Honduras or its agencies.

Efforts Made by the Ministry of Economy of Honduras for Obtaining Metrological Legislation

In the last few years, the Government, in spite of the above problems, has been making concrete efforts to improve this situation. For example, the Ministry of Economy promotes metrological programs and standardization and quality control. A committee was formed with representatives and authorities of the Ministry and of some other sectors that have direct competence in the affected fields for the elaboration of a draft legislative decree to establish the International Units System, SI, as the sole units to be used within the whole country. At the Department of Engineering and Standardization of the General Directorate of Industries, Engineer Juana Chambasis Lorenzana made plans for making some corrections and additions to the draft of the Committee. Up to now, it has not been possible to obtain approval by the Legislative or the Executive.

Inconveniences Suffered from the Lack of Adequate Legislation on Weights and Measurements

The lack of an effective law on weights and measurements causes inconvenience among which I count:

a) Delays in the adoption of modern and efficient technology for the industry of the country.

b) The absence of guarantees in transactions made between vendors and purchasers.

c) Inconvenience for other governmental actions involving measures, such as price control, the establishment of technical standards for industrial products, etc.

d) Inappropriate use and interpretation of some measurement equipment in the country.

e) Improvisation with out-of-date laws for regularizing commercial transactions and the use of measuring instruments.

f) Out-dated methods and techniques for making measurements.

g) Confusion in legal writings and lack of uniformity.

h) Incomplete assurance in the exchange of technology with countries that have a complete metrological service.

i) Lack of control of imported metrological instruments and equipment entering local market without prior tests of the precision stated by the manufacturer and of the suitability of the model for the intended use.

j) Lack of legal competence for exercising an initial and periodic control of the measuring instruments used in all productive operations in the country.

Potential for a Weights and Measures Law in Honduras

In all industrialized countries, it is essential to have an effective law on weights and measures and an organization in charge of implementation. This is also a necessity in a developing country like Honduras. To obtain the effective implementation of such legislation, Honduras has some qualified personnel in industry, education, technical investigation, and commerce who could meet in committees called by the General Directorate of Industries and Internal Commerce in the Ministry of Economy. At this time, a Committee of foreign advisors with wide experience in the execution of this type of program is not available. And at this time, the Ministry of Economy does not have its own technical support, equipment, or laboratories to support a weights and measures law. However, the National Autonomous University of Honduras (UNAH) has varied laboratory equipment (chemical, physics, engineering, etc.) and is willing to participate in any project that will extend its services through tests and assays, as well as to increase its fields of research. The same willingness to participate exists in some private laboratories in the country. The Department of Engineering and Standardization, which is in charge of standardization, metrology, and quality control, contemplates the establishment and maintenance of a metrological laboratory. The General Directorate of Internal Commerce will coordinate its price control program with the weights and measures control of the Department of Engineering and Standardization and thus be responsible for a part of the Weights and Measurements Law.

STANDARDS OF WEIGHTS AND MEASURES IN INDIA

by

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Introduction

In this paper, I shall describe the measurement standards and comparators used in the weights and measures service in India and discuss some problems we face in making and calibrating these. Weights and measures service began in India in a systematic way about 25 years ago and is now well established. Its main concern has been the correctness of mass, dimension, and volume measurements made in trade and commerce. In that task, the weights and measures organization of India has achieved a good degree of success. There are plans to include in this service the verification of flowmeters, pressure gages, clinical thermometers, electrical energy meters, etc., and to extend its activity in the area of engineering metrology relating to quality control in production in small-scale industries.

Organization

I shall first describe briefly the organizational aspects relating to the measurement hierarchy in our weights and measures service. In India, weights and measures is a state subject, and the legislation for this service and its implementation are the responsibility of the state government. There are 22 states and 9 union territories in India. Each has a department of weights and measures which is often a part of the ministry of industries of the state. The chief or the controller of weights and measures in a state coordinates that activity in his state. Actual measurements and verifications are made at the district and lower levels. The field work, that is, verification of weights and measures and weighing and measuring instruments in use in trade and those made by a manufacturer, is done by an inspector of weights and measures. He is equipped with a working standard length measure cum comparator, a set of working standard weights and balances, and a set of working standard capacity measures. The inspectors' working standards are verified at district headquarters which is equipped with similar sets of secondary standards. At present, a little over 100 sets of secondary standards and about 1,000 sets of working standards are in use in India.

The original plan was to establish in each state a metrological laboratory equipped with reference standard measures and corresponding measuring instruments for verification of the secondary standards. Only the reference standards were to be calibrated at the National

Physical Laboratory for traceability to the national standards. That target has not been achieved, and at present, the National Physical Laboratory verifies both the reference and the secondary standards. In the future, the responsibility of maintaining the reference standard measures and verifying the secondary standards will be vested in the Reference Standard Laboratories. Five such laboratories are being established in different parts of the country.

The overall coordination of weights and measures activities in the country is done by the Directorate of Weights and Measures of the Government of India. Its responsibilities are drafting of rules and specifications for adoption by the parliament and by the state legislative bodies, training of weights and measures personnel, and ensuring the supply of measurement standards and the means of their verification. The last two tasks are actually carried out respectively by the Mint of the Government of India in Bombay and the National Physical Laboratory in New Delhi. A convention of the state controllers of weights and measures is held annually to discuss the special problems of individual states and to ensure the uniformity of the weights and measures services throughout the country. These conventions are attended by representatives of the National Physical Laboratory, the India Government Mint, the Indian Standards Institution, and other organizations associated with the weights and measures service in India.

The Directorate of Weights and Measures runs the Institute of Legal Metrology at Ranchi for training of weights and measures personnel. This Institute conducts courses on the science of techniques of measurement and on the law relating to the weights and measures activity. All weights and measures personnel in India are initially trained at this Institute. Training at a higher level in measurement techniques is given by the National Physical Laboratory and in documentary standards by the Indian Standards Institution, also in New Delhi. Several other Asian and African countries make use of these facilities for training their weights and measures personnel.

The Directorate of Weights and Measures is now taking over part of the responsibility for calibration and measurement of standards at the reference and secondary levels. The reference standard laboratories mentioned earlier are being established for that purpose. Two of these laboratories have just started functioning. The future extension of weights and measures services is expected to take place through these laboratories.

Measurement Hierarchy

The weights and measures service now maintains measurement standards for mass, length, and volume. There are four hierarchical levels in this system of measurement. This is depicted in table 1. In this system, the Directorate of Weights and Measures drafts the specifications for standard measures and the measuring instruments,

TABLE 1

Hierarchy of Measurement Standards
Used in Weights and Measures Service

LENGTH	MASS	VOLUME
National standard	National standard	
NPL transfer standard	NPL transfer standard	
Reference standard	Reference standard	
Secondary standard	Secondary standard	Secondary standard
Working standard	Working standard	Working standard
Commercial length measures	Commercial weights and weighing machines	Commercial capacity measures

maintains the reference standards, and verifies the secondary standards. The National Physical Laboratory maintains the national standards and verifies the reference standards. The India Government Mint manufactures all the standard measures and the secondary standard comparator. Both the National Physical Laboratory and the India Government Mint carry out R&D work on the design of standard measures and measuring instruments. The weights and measures departments of the states maintain the secondary and the working standards and verify the working standards and the measures and measuring instruments in use in trade and commerce.

Secondary standard balances for verification of working standard weights and working standard balances for verification of commercial weights are made commercially in the country. New balances before installation are checked and certified by the National Physical Laboratory. In the future, the Reference Standard Laboratories may take over that work. The reference, secondary, and working standards for weights and measures are used at their face values, and no corrections are applied for their true values. Therefore, these standards are maintained so that their values are within the specified limits of tolerance. Any defective measure is either adjusted or replaced at the time of verificiation. The recommended periods between verifications are two years for the reference standards, three to five years for the secondary standards, and one year for the working standards.

Mass Measures and Balances

All the gram and kilogram weights of the reference, secondary, and working standard sets are made of admiralty bronze. The specification permits the use of nickel-chromium alloy and austenitic stainless steel, but these are not in use yet. The 500 mg to 10 mg weights of the reference standard set are made of platinum wire, the 500 mg to 50 mg weights of the secondary standard are made of cupro-nickel sheet, and the 500 mg to 100 mg weights of the working standard are made of admiralty bronze. The smaller weights are all made of pure aluminum sheet or wire. The gram and kilogram weights of the secondary and the working standard sets have provisions for mass adjustment. The reference standard weights do not have this provision. All the standard weights are calibrated on the assumed density of 8,400 kg/m^3, which is the density of the reference standard gram and kilogram weights. The denominations and the tolerances of the standard weights are shown in table 2. There is a proposal to make the tolerances finer for the reference standard weights and bring these at par with the class E_2 weights recommended by the International Organization of Legal Metrology (OIML).

The specifications for the secondary and the working standard balances are shown in table 3. These are two-pan, equi-arm balances and are made commercially in the country.

TABLE 2

Denomination and Tolerances of Standard
Mass Measures Used in Weights and Measures Service

Denomination	Tolerance in mg					
	Reference		Secondary		Working	
20 kg					+200	-100
10 kg			+50	-25	+100	- 50
5 kg	+25	-12.5	+25	-12.5	+ 50	- 25
2 kg	+10	- 5	+15	- 7.5	+ 30	- 15
1 kg	+ 5	- 2.5	+10	- 5	+ 20	- 10
500 g	+ 2.5	- 1.25	+ 5	- 2.5	+ 10	- 5
200 g	+ 1	- 0.5	+ 4	- 2	+ 8	- 4
100 g	+ 0.5	- 0.25	+ 3	- 1.5	+ 6	- 3
50 g	+ 0.25	- 1.2	+ 2	- 1	+ 4	- 2
20 g	+ 0.1	- 0.05	+ 1.5	- 0.75	+ 3	- 1.5
10 g	+ 0.04	- 0.02	+ 1	- 0.5	+ 2	- 1
5 g	+ 0.04	- 0.02	+ 0.8	- 0.4	+ 1.6	- 0.8
2 g	+ 0.04	- 0.02	+ 0.6	- 0.3	+ 1.2	- 0.6
1 g	+ 0.04	- 0.02	+ 0.4	- 0.2	+ 0.8	- 0.4
500 mg	+ 0.04	- 0.02	+ 0.4	- 0.2	+ 0.8	- 0.4
200 mg	+ 0.04	- 0.02	+ 0.2	- 0.1	+ 0.4	- 0.2
100 mg	+ 0.04	- 0.02	+ 0.2	- 0.1	+ 0.4	- 0.2
50 mg	+ 0.02	- 0.02	+ 0.1	- 0.05	+ 0.2	- 0.1
20 mg	+ 0.02	- 0.02	+ 0.1	- 0.05	+ 0.2	- 0.1
10 mg	+ 0.02	- 0.02	+ 0.05	- 0.02	+ 0.1	- 0.05
5 mg	+ 0.02	- 0.02	+ 0.05	- 0.02	+ 0.1	- 0.05
2 mg	+ 0.02	- 0.02	+ 0.05	- 0.02	+ 0.1	- 0.05
1 mg	+ 0.02	- 0.02	+ 0.02	- 0.02	+ 0.05	- 0.05

TABLE 3

Specification for Standard Balances
Used in Weights and Measures Service

Capacity	Sensitivity figure in mg/scale div.	Minimum distance between scale divisions in mm	Maximum variation in sensitivity figure	Minimum Overall Accuracy
A. Secondary standard balance				
10 kg	25	2.0	10%	25 mg in 10 kg
5 kg	7.5	1.5	10%	7.5 mg in 2 kg
1 kg	1.5	1.0	10%	1.5 mg in 100 g
50 g	0.4	1.0	10%	0.4 mg in 5 g
2 g	0.02	0.75	10%	0.02 mg in 1 mg
B. Working standard balance				
50 kg	100	2.0	20%	100 mg in 10 kg
5 kg	10	1.5	20%	10 mg in 500 g
200 g	1.0	1.0	20%	1 mg in 5 g
2 g	0.02	0.75	20%	0.02 mg in 1 mg

Length Measures and Comparators

All the 3 standard length measures are meter bars. The reference standard bar has an "H" section and is made of 58 percent nickel steel. The secondary and working standard meter bars have rectangular sections and are respectively made of 58 percent nickel steel and of pure nickel. The main specifications of the length measures are given in table 4. The reference temperature of calibration of the length measures is 20°C. The standard length measures and the standard weight sets are made by the India Government Mint. The reference standard meter bar is still in the development stage.

The carrying case of the working standard meter is designed to serve as a comparator for the measurement of both line and end gages. The meter bar is provided with a graticule and a magnifier for estimation to 0.1 mm. The secondary standard comparator used for verification of the working standard meter is a simplified form of the transverse comparator. It has a least count of 0.01 mm. The reference standard comparator for verification of the secondary standard meter will be a longitudinal comparator with 0.001 mm least count. It is now under development.

Capacity Measures

The standard capacity measures are cylindrical vessels made of admiralty bronze and are provided with striking glasses. These are made by the India Government Mint. Their denominations and tolerances are given in table 5. The reference temperature for their calibration is 27°C. The secondary standard capacity measures are calibrated gravimetrically using the reference standard mass measures and balances for weighing. Distilled water is used as the liquid of known density. The working standard capacity measure set contains also two one-mark pipettes of 10 ml and 5 ml capacities and one 5 ml pipette graduated at every 0.1 ml.

Current Developments

The work in making the new set of reference standard weights is being carried out both at the National Physical Laboratory and at the India Government Mint. These weights will be made either of nickel-chromium alloy or of austenitic stainless steel. Initially there was difficulty in getting the alloy bars, but that problem has been solved. The new set of reference standard weights may come into use soon. High precision balances required for use at the reference standard level are not being made in India. It will be uneconomical to try to develop such balances in the country at present. While making standard-weight pieces from nickel-chromium bars, we found that rhodium plating can be a convenient and precise method of adjusting their masses. We have hardly any knowledge about the durability of the electroplated rhodium film and will welcome comments on the advisability of using rhodium-plated weights when the accuracy

TABLE 4

Specifications for Standard Length Measures
Used in Weights and Measures Service

Parameter	Specification		
	Reference	Secondary	Working
Material	58% nickel steel	58% nickel steel	Nickel
Shape	H section	Rect. section	Rect. section
Size in mm	25 x 25 x 1030	38 x 15 x 1030	30 x 15 x 1030
Graduation	1 mm from -1 mm to 1001 mm	1 mm from -10 mm to 1000 mm	1 mm from -10 mm to +10 mm
	0.1 mm between -5 to -4 mm and +4 to +5 mm		5 mm from +10 mm to 1000 mm
Width of graduation	8 μm to 10 μm	30 μm to 50 μm	50 μm to 80 μm
Maximum variation of line width in one scale	± 10%	± 10%	± 10%
Maximum permissible error	± 10 μm between any two graduation marks on main scale	$\pm (25 + \frac{L}{40})$ μm	$\pm (50 + \frac{L}{20})$ μm
	± 5 μm between any two graduation marks on fine scales	Where L is the nominal length in mm between two graduation marks.	

TABLE 5

Denomination and Tolerance of Capacity Measures
Used in Weights and Measures Service

Denomination in cm^3	Tolerance in cm^3	
	Secondary standard	Working standard
10000		$\pm$ 8
5000	$\pm$ 2	$\pm$ 4
2000	$\pm$ 1	$\pm$ 2
1000	$\pm$ 0.8	$\pm$ 1.5
500	$\pm$ 0.5	$\pm$ 1
200	$\pm$ 0.4	$\pm$ 0.8
100	$\pm$ 0.3	$\pm$ 0.6
50	$\pm$ 0.2	$\pm$ 0.4
20	$\pm$ 0.1	$\pm$ 0.2

required is almost 1 part in 10^6. Another problem we face in mass calibration is to know how non-magnetic the weight piece is. For weights made at NPL, we can measure the magnetic property of the material. But this is not convenient when we calibrate weight pieces made by others. It will be useful if a simple quantitative method is recommended to check whether the magnetic property of a weight piece is within the tolerance limits for its class of weight.

The development of the reference-standard length measure has been nearly completed at the India Government Mint. It will soon be put into use. The main problem in its fabrication was to make the graduated face flat to within 0.05 mm. The out of flatness of the graduated face does not materially affect the accuracy of the graduation but makes the calibration of the meter bar very inconvenient.

The reference standard comparator is being developed at the National Physical Laboratory. The specification recommended a longitudinal comparator of 0.001 mm least count. To reduce the size and the cost we designed a comparator based on the Eppenstein principle. The first prototype of the comparator will be completed soon. We are now faced with a problem which we did not anticipate at the design stage. The user of the comparator must have the means to check the alignment of the optics. The tolerances are quite large, but the alignment of several different components is required. We are trying to design one device which will enable the user to check all the alignments.

Conclusions

These problems of fabrication of standard measures of comparatively high precision and their calibration are faced by metrologists working in well-equipped laboratories. Verification of measures and measuring instruments in use presents other problems which are perhaps more difficult to solve. In a country like India, measurements in the field have to be carried out often with the bare minimum of equipment and under hostile environment. A large variety of measures and measuring instruments of a wide range of sophistications are required to be verified, and the metrologists available for that work are not always fully trained.

These difficulties will increase in the future as metrology has to keep pace with the rapid progress of industry and technology in the country. There is a plan to establish in India a national calibration service, to coordinate the activities of different organizations engaged in metrology, and to ensure reliability and traceability in all the fields of measurement. In that service, the weights and measures organization of India will have the main responsibility for reaching and serving the actual users of measures and measuring instruments.

WEIGHTS AND MEASURES ACTIVITIES IN LIBERIA

by

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Introduction

The Bureau of Standards was created by an Act of Legislature in May 1972 and charged with the overall responsibility of supervising, implementing, and enforcing standardization, quality control, and metrological (weights and measures) activities in the country. Since its creation, the Bureau has made some significant contributions to the overall economic development of the country. Prior to 1972, standardization in the true sense of the word did not exist in Liberia. The job of standardization was entrusted to several government agencies, each doing what it saw fit.

The situation is quite different in Liberia today, thanks to the wisdom of President William R. Tolbert, Jr., for taking such a giant step. Though very young compared to other standards bodies, the Bureau is gradually taking its place among the international community in standardization.

Organizational Structure of the Bureau

The Bureau is headed by a Director, who is assisted by a Deputy Director. There are three sections in the Bureau, namely Standards Specifications, Quality Control, and Metrology. Each of these sections is headed by a sectional head who is responsible for supervising the day-to-day work of the section.

History

To help the reader to understand this paper, it is only proper to give some historical highlights of weights and measures practices in Liberia. Up until 1976, the legal measuring system in Liberia was the imperial system. In 1976, the legislature enacted a law which made the metric system the only legal system of measurement in the country. Since this declaration, the Bureau has aimed to make the public aware of the importance of weights and measures in the total life of a nation. Knowing that the economic development of a country cannot be divorced from metrology, the Bureau of Standards is doing all it can to bring to the attention of the Government the vital role that metrology plays in a nation's life.

Present Weights and Measures Activities in Liberia

In Liberia today, weights and measures activities are centered around calibration of gasoline filling stations, calibration of gasoline tank trucks, calibration of measuring devices used in trade and commerce, etc. As a government agency, the Bureau is working in the interest of the general public, and all the above tasks are performed free of charge except the calibration of gasoline tank trucks. Even in this case, government trucks are not charged the modest fee of $5 charged to other people.

Upon inspection and calibration of the above-mentioned categories of businesses, a "Standards Certificate" is issued to enable the owner to operate for a period of six months. The law provides that any of the above businesses found operating without a "Standards Certificate" is liable to a fine ranging from $1 to $10,000. The rationale behind this penalty is to encourage the businesses concerned to perform according to rules and regulations.

The Bureau of Standards, by an Act of Legislature, is empowered to seize and detain any measuring devices that are found to be defective. In the case of gasoline pumps, when a defect is discovered, the pump is sealed and the owner notified that he is not to use the pump in commerce until it is calibrated by the Bureau of Standards and/or an independent repair man. The law provides that any person who removes a seal placed by the Bureau of Standards without notifying the Bureau is liable to a fine of $5,000 and/or a six-months' jail sentence.

Problems of Weights and Measures Activities in Liberia

The reader of this paper may wonder why activities of weights and measures are so limited in Liberia. Of course, there are vast areas to be covered, but the problem of logistical support should not be overlooked. In Liberia, as in other developing countries, the financial problem is number one. To fully cover the vast spectrum of commerce with weights and measures activities demands a great deal of money. Moreover, there exists some lack of knowledge on the part of politicians. At present, the basic instruments and equipment for the smooth operation of metrological activities do not exist at all.

The second problem is that of the lack of qualified manpower. Because many people have not come to know the interface of standardization, quality control, and metrological activities and the low salary offered, the recruitment of personnel is our number two problem. At present, we only have three staff members to cover the whole country of 43,000 square miles.

What Is Being Done About the Problems

The Bureau, having realized the tremendous problems that lie ahead, has undertaken the following:

1. The enactment of comprehensive weights and measures laws to replace the old ones.

2. Encouraging the Government to put more money into metrological activities.

3. Encouraging the Government to declare its intention of "going metric."

4. Recruiting more qualified personnel.

We at the Bureau of Standards feel that if the above plans are implemented, the weights and measures activities in Liberia will surely take on a new direction towards improvement.

Conclusion

Though lacking most of the vital ingredients needed in weights and measures activities, the Bureau of Standards has brought about considerable improvement in the area. Presently, the consumer is assured that when he buys a pound of meat from the butcher, it is a pound of meat. He is assured that when he drives his car to the gasoline filling station and requests a gallon of gasoline, he gets a gallon.

As time goes on and the Bureau strengthens its manpower, all other areas of trade and commerce will be covered. We feel that weights and measures services are beneficial to both the consumer and the producer and as such must claim the attention of all concerned.

A NATIONAL SYSTEM FOR THE CALIBRATION OF STANDARDS AND MEASURING INSTRUMENTS IN MEXICO

by

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Introduction

The industrial development of Mexico makes it of paramount importance to start a national system of calibration and certification of testing equipment and measuring standards used in the production of goods and services in order to guarantee to the domestic and foreign consumer that the quality of products and amount received are reliable.

The Direccion General de Normas (General Directorate of Standards--DGN) in no way has the human and material resources to render calibration service to each and every one of the measuring instruments and standards used in industry for each and every one of the measurable magnitudes (length, area, volume, flow, force, pressure, temperature, time, electric quantities, etc.). The technique used, equipment, and personnel are quite specialized and dissimilar, aside from the high cost of installing an adequate laboratory which is always incomplete as methods, standards, and measuring apparatus vary continuously.

On account of circumstances, it is considered that conservation and transmission of measures in the national territory lean upon a national system which will comprise all metrology laboratories of private companies and official agencies that are in operation in the country. In this way, the technical know-how of these laboratories could be made generally available. At present, knowledge of their activities is rather limited. The effective operation of a national measurement system would encourage modernization and technical improvement of all establishments. Some of them with confidence in their own competence could exercise the option of intervening in the verification and calibration of standards and measuring instruments used in the national industry in accord with the overall direction and control of DGN.

Description of System

1. The national system of verification, calibration, and certification of standards and measurement apparatus has the purpose of regulating and promoting veracity and reliability of measurements carried out in the fields of science, technology, industry, and commerce by means of standards and measuring apparatus duly certified, calibrated, and adjusted.

2. The dispositions of this system are applicable to manufacturers, importers, repairers, merchants, and those using standards and measuring devices in the national territory.

3. A national registry of standards and measuring devices has been established.

4. Manufacturers and importers must verify and calibrate, at the beginning, each and every one of the measuring devices manufactured or imported in order to obtain the corresponding official certificates and registry numbers, in cases and terms pointed out by the general regulations of this Decree, before putting them at the disposal of seller or user.

5. Repairmen of measuring devices must verify and calibrate each and every one of the devices repaired in order to obtain the corresponding official certificates in cases and terms pointed out by the general regulations of this Decree before putting them at the disposal of users, as well as showing DGN the registry number of the repaired apparatus and what the repairing consisted of.

6. Merchants are not allowed to sell standards without their corresponding official certifications and registry numbers.

7. Users of standards must demand from their suppliers the corresponding official registry. It is prohibited to use for any purpose standards without their official certificates and registry numbers.

8. Users of standards must verify them periodically.

9. The official certification required for standards and measuring devices is issued by the Secretaria de Fomento y Fomento Industrial (Secretariat of Development and Industrial Development) through DGN, based on the judgment of verifications and calibrations made by official laboratories or private ones duly qualified.

10. Laboratories referred to above will be the ones that comprise the voluntary acknowledged laboratories of the national system with specific authorization in metrology.

Conclusion

It is intended with the present system to build up the corresponding mechanism that will permit a better development to integral standardization in accordance with national needs and international practice. It is intended also to solve problems in commerce, industry, and technology, which require the organized and recognized supervision in verification, calibration, and certification of standards and measuring devices in order to ascertain results that measurements made are reliable.

THE DEVELOPMENT OF WEIGHTS AND MEASURES ADMINISTRATION IN NIGERIA AFTER THE COLONIAL ERA

by

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Weights and measures activity may be ranked as one of the most pervasive activities in the life of every individual in human society. It enters into the economic arrangements and daily concerns of every family. It is in the realization of this that the Government of Nigeria thought it imperative to ensure a fair deal in any transaction involving the determination of quantity.

During the colonial era, the administration of weights and measures in Nigeria was saddled on the Nigeria Police, who were already overburdened. The police lacked many requirements to be able to carry out the weights and measures activities efficiently and effectively. First, they lacked the manpower and training necessary to be able to certify any weighing or measuring instrument accurately for transactional purposes.

Second, the police had no equipment to carry out their onerous job. At best, the Inspector of Police merely issued "Certificates of Justness" in respect to instruments without testing them. These, together with other problems, militated against the efficient administration of weights and measures in Nigeria. As a result of this lack of a virile weights and measures administration, equipment used for the buying and marketing of agricultural produce (which were our main foreign exchange earners, namely, palm kernel, palm oil rubber, cotton, groundnuts, cocoa, and ginger) was not properly tested and maintained. Consequently, the Government was heavily surcharged for shortweight bagged commodities which ran to millions of dollars. This no doubt led the Nigeria Government to withdraw the service from the police and to contemplate the use of some other organization capable of administering weights and measures controls in the country.

Just before the Nigerian Independence in 1960, the need for a proper setup for a weights and measures service in the country became even more imperative. Towards this end, a United Nations expert in weights and measures was engaged by the Federal Government to draft the Weights and Measures Act which was enacted in 1962 and to establish a School of Legal Metrology at Oshodi-Lagos. The first batch of trainee-inspectors of weights and measures recruited in 1961 underwent two years of theoretical and practical training after which they sat for the Testamur Certificate of the British Institute of Trading Standard Administration (formerly called the British Institute of

Weights and Measures Administration) which is the Nigerian qualifying examination for inspectors.

Inspectors later go on attachment to local weights and measures authorities in the United Kingdom where they receive further courses of instruction and then sit for the Board of Trade Examination for qualification as Inspectors of Weights and Measures in the United Kingdom. In the past few years, the Nigerian inspectors have had the opportunity of visiting other weights and measures establishments in India, Western Germany, and Australia, and the wealth of experience gained during these visits has tremendously improved our own setup and administration.

One of the problems facing the Administration of Weights and Measures in Nigeria today is the dearth of qualified inspectors. Nigeria, with a population of about 80 million and an area of 913,091 square kilometers (373,640 square miles), still needs the services of more inspectors of weights and measures to cover all the towns and villages more effectively. At the moment, we have a weights and measures office in each of the 19 states, and with only 40 inspectors (which averages about 2 inspectors per state), the administration is overextended in its duty to test and certify the accuracy of all trading scales and measuring instruments used in the Federation.

The British Testamur Examination which produced only 10 inspectors in 4 years did not provide an answer to the problem. Moreover, the abolition of the Testamur Examination by the Institute as a result of the phasing out of the old-style United Kingdom qualifying examination system was of special concern to the Federal Government of Nigeria. A United Nations expert in weights and measures was engaged in 1975 under the United Nations Development Program (UNDP) to reorganize the training school. The report of this expert has been accepted by the Federal Government. As a result, a Nigerian Certificate in Weights and Measures--a Diploma Certificate--is to be issued by the Yaba College of Technology. It will replace the Testamur Certificate. This new Nigerian Certificate will have international recognition, and it is envisaged that students for the three-year course will be drawn from Nigeria and other neighboring African countries. The subjects for the course include mathematics, law in relation to weights and measures, weights and measurements technology, care and custody of standards and balances, practical verification, statistics, electronics, and economics. Many industrial establishments in the measuring and weighing business and the Federal Government will readily absorb graduates from the course. It will not be long before we attain our ultimate goal of providing a weights and measures service to every nook and corner of the country.

The activities of the Department can be classified under three main headings--verification, inspection, and technology. Under verification, inspectors test all weighing and measuring appliances in use for trade to see whether they are performing well within

permissible error allowances. If they are correct, they are stamped as fit for use for trade and "Certificates of Verification" are issued. Incorrect equipment is rejected and notices given to the users to have them repaired and resubmitted for further tests. During inspection, the inspectors go round to see that the original accuracy is maintained within the tolerances permitted. Breaches of the law are usually minimized by the knowledge that legal proceedings against offenders can be instituted with a high probability of conviction by a magistrate's court. A lot of maturity is required of the inspectors to see that offences committed as a result of intent to defraud are prosecuted rather than those arising from ignorance or carelessness.

Under technology, the inspectors ensure that our standards (primary, secondary, tertiary, and working) are properly kept and maintained in our standards laboratories in Lagos and in the state offices. A lot of new techniques in the testing of bulk flowmeters and taximeters are being acquired so that inspectors can cover these areas of enforcement of the Decree.

Nigeria went completely metric on January 1, 1979, with the promulgation of the Weights and Measures (Amendment) Decree 1978 which gives inspectors wide powers, including the sealing of premises where offenses have been committed. It is therefore lawful to use only metric units for the purposes of trade and other commercial transactions.

With improved staffing and training, it is hoped that in the next 10 years Nigeria will be able to boast of a very efficient and effective Weights and Measures Administration comparable to those in some advanced countries.

THE PRESENT STATE OF THE ADMINISTRATION OF WEIGHTS AND MEASURES IN SRI LANKA

by

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Colombo, Sri Lanka

Legal Metrology in Sri Lanka

Systems of weights and measures have been in existence in the Indian subcontinent for nearly 3,000 years. These systems are described in a manual of statecraft written during the reign of Emperor Asoka of India. The ruins of Mohindejara and Harappa demonstrate that the concept of standardization existed even in these early times. In Sri Lanka, large-scale irrigation schemes depended on channels with very small gradients, an indication of the ability even at that time to measure with a fair degree of accuracy. During the 10th and 11th centuries, Sri Lanka was a trading center for exchange of goods between the West and China. Therefore, one can presume that some kind of control of quantities was exercised.

In the year 1878, a Law was established to control the weights and measures in Sri Lanka, and under this Law, standards of mass, length, and volume were imported and distributed to the district offices for testing and stamping of weights and measures of traders, but no central office, laboratory, or national standards were available to calibrate the district standards periodically. In fact, once given in 1878, nothing was done subsequently to calibrate these standards. Under a new Weights and Measures Law in 1954, for the first time standards for mass (the pound) and length (the yard), verified and stamped at the Standards Department of the Board of Trade in England, were brought into use in Ceylon and were proclaimed as Ceylon Standards.

It was only in the year 1955 with the enactment of the Weights and Measures Ordinance and Regulations in Sri Lanka, together with the establishment of the Weights and Measures Standards Laboratory, that some meaningful action was taken to regularize the system of weights and measures. It is this Law and the subsequent amendments which provide for the establishment and maintenance of national and derivative standards of measurement: the (Amendment) Act No. 7 of 1971; Weights and Measures (Amendment) Law No. 24 of 1974, and the Weights and Measures (Amendment) Act No. 16 of 1979. Under the Weights and Measures (Amendment) Law No. 24 of 1974, the International System of Units (SI) as the principal system of measurement is now legally recognized in Sri Lanka. However, the "yard" and the "pound"

defined in relation to the meter and the kilogram can be lawfully used concurrently with the units of the international system.

The original Law established in 1955 was limited to the measurement of length, mass, and volume, and the national and derivative standards were available for only these three units. The establishment of national and derivative metric standards in SI commenced in 1974 and are in the process of being progressively built up under the country's metrication program.

The Weights and Measures Regulations which lay down specifications for measuring instruments used in trade are confined to the measurement of length, mass, and volume only. These regulations formulated in 1955 have now been revised completely in accordance with the International Organization for Legal Metrology (OIML) recommendations. The scope of these regulations will be extended very shortly.

1. Structure and Function of the National Service of Legal Metrology

The emphasis so far has been on metrology confined to compulsory verification of measuring instruments used in the determination of length, mass, and volume in trade.

The central office for both administrative and technical purposes is situated in the administrative capital of Sri Lanka and comprises a laboratory installed and equipped for maintaining the national and derivative standards. The working standards used in the field by inspectors are calibrated against the derivative standard. One local laboratory is situated in each district where all testing and stamping of weights and measures and weighing and measuring instruments are done by inspectors.

2. Commodities Sold in Containers and Packages

Weights and Measures (Amendment) Act No. 7 of 1971 requires by an order published in the gazette that commodities which are put up for sale in a container or a package should carry conspicuously on the outside of the container or package a statement of the net weight, volume, or length of the contents where such article has been declared to be a "specified article." Almost all commodities commonly used and which are marketed by weight, volume, or length and are prepacked have been brought under this requirement by being declared as "specified articles." When products in a container are also encased in a package, the statement should appear both on the container and the package. Under the Metric Conversion Law, a start has been made to mark the net contents in fixed metric quantities only for tea, toothpaste, and paint. For other scheduled commodities, it would suffice if the equivalent metric quantity is marked.

The policy of the Democratic Socialist Republic of Sri Lanka is for free and open trade. Import restrictions have been liberalized. As a

result of this policy, consumer goods have not only been imported freely but consumers have been ensured of the continuing availability of a very wide range of consumer products. Consequently, the responsibility of protecting the consumer has become increasingly relevant. The Consumer Protection Act No. 1 of 1979, which is intended for this purpose, was proclaimed in January 1979. To meet this demand to protect the consumer, the metrology laboratory will expand its capabilities.

Petrol (Gasoline) Pumps

Since the Metric Conversion Law of 1974 came into force, petrol pumps are being converted to read in metric units. Along with this conversion, petrol pumps are verified and stamped by inspectors. Due to frequent breakdown of calibrated pumps, a problem has arisen.

Petrol pumps initially designed and manufactured to deliver in units of the imperial gallon, its multiples, and sub-multiples had to be converted to deliver in the metric unit of liters, which is a comparatively smaller unit of volume. This requires the display mechanism to work faster with a consequent increase in the number of breakdowns. Apart from this, the metering device also goes out of calibration fairly often requiring adjustment of the metering chamber which requires the breaking of the mark of authentication by the inspector. Dealers of fuel have to get their broken-down pumps repaired very quickly in order to serve the customers. This means the inspector's mark of authentication has to be broken. A large number of broken pumps and lack of transport facilities hinder the recalibration and stamping by inspectors. Simply because an inspector cannot be made available, the dealer cannot be expected to refrain from using a repaired pump, thereby possibly causing a major breakdown of the transport system. Therefore, a reasonable solution has to be found to allow the dealer to use such pumps till they are calibrated and stamped, but at the same time, consumers will have to be notified of the condition of the pumps by implementation of needed regulations.

Preliminary investigations in progress aim to develop controls over gas, water, and electrical energy meters, hydrometers used in the rubber industry, and moisture meters used in the grain trade.

Moisture Meters

Resistance and capacitance electrical moisture meters are used to determine the moisture content of grain. The Paddy Marketing Board, the major buyer, is using the resistance type, commonly called Keth meters. The OIML method, a direct drying method, takes a fairly long time and is not suited to the use for purchasing paddy at a store or in the fields. A survey to correlate the OIML method with the readings of the Keth meter is being carried out.

Alcoholometry

The OIML method for ethylalcohol content has been recognized officially, but in practice, Sykes hydrometers are used, and Ebuliometers are also used. Reconciliation of these methods has been achieved, and rules are being prepared. With the present shortage of fuel and its ever-increasing prices, it is expected that this measurement may become important in the very near future because there exists the possibility of producing alcohol in coconut plantations as an alternative fuel.

Thermometry

At this initial state, thermometry is confined to testing of clinical thermometers. Steps are being taken to provide the district laboratories with facilities to test clinical thermometers because different types of clinical thermometers from a number of countries are available in the market. Very few of these bear any certification.

RECRUITMENT AND TRAINING OF SUDANESE WEIGHTS AND MEASURES OFFICERS

by

Mr. Babiker Abu El Hassan
Assistant Director
Weights and Measures Administration
Khartoum, Sudan

The purpose of my paper is to trace the development of the training of our weights and measures staff and to describe future training policy.

The term "Officer" means a person appointed under Section 26 of the Weights and Measures Ordinance 1955 to be a Weights and Measures Officer of the standards section of the Ministry of Commerce and Supply. Section 26 of that Ordinance reads as follows:

> "1. The Under Secretary may from time to time appoint persons satisfying prescribed qualifications to be Weights and Measures Officers of the Standards Section of the Ministry of Commerce and Supply to administer the provisions of this Ordinance. All such appointments shall be published in the Gazette.
>
> "2. The Under Secretary may delegate to any council established by warrant under a local government ordinance for the time being in force the power to appoint officers for its area."

Therefore, attention has been given to the recruitment, training, qualifications, and appointments of Sudanese Weights and Measures Officers even before the Weights and Measures Ordinance came into effect.

In August 1952, the Sudan Government signed a contract with a British expert in weights and measures who was holding the British Board of Trade certificate of qualifications for weights and measures inspectors and who was a member of the British Institute of Weights and Measures Administration. That was Mr. L. G. Theobald. His principal duties were as follows:

1. To assist in the establishment of a comprehensive weights and measures service in the Sudan.

2. To train initially seven Sudanese weights and measures officers.

3. To establish a school for the training of weights and measures officers.

The title of his post was "Training Officer." He was working under the direction of a British Weights and Measures Inspector, Mr. J. L. Penn, who was appointed before him to establish a nationwide weights and measures service in the Sudan.

The Weights and Measures Ordinance 1955 was passed by Parliament and came into force on June 15, 1955.

Structure and Extent of the 1955 Ordinance

The Ordinance consists of four parts as follows:

Part I contains the title, the repeal of previously existing laws, and the application, interpretation, and enforcement of the Ordinance.

Part II is concerned with the Sudanese units of weights and measures.

Part III deals with the physical standards.

Part IV is a general part. It contains the general provisions affecting the public, inspection and verification of trade equipment and goods, ministers and officers given responsibility and power, prosecutions of weights and measures offenses, penalties, etc.

Weights and Measures Regulations 1956

In the exercise of the powers conferred upon him by Section 39 of the Weights and Measures Ordinance 1955, the then Minister made the regulations which came into effect on May 15, 1957.

These regulations fall into two groups as follows:

1. Legal technical specifications with which weighing and measuring instruments must comply.

2. Regulations which have penal clauses under Article 40 of the Weights and Measures Ordinance 1955 and with which the trader must comply.

These latter amplify the provisions of the Ordinance.

This is the general picture of the Ordinance and Regulations. Accordingly, a guide for recruitment, training, and appointment of weights and measures officers has been drafted. Terms for appointment to posts of weights and measures officers have been approved by the Public Service Commission after careful negotiations.

The Minister of Commerce and Supply is empowered under Section 39, i.e., of the Weights and Measures Ordinance 1955, to make regulations prescribing the qualifications necessary for appointments as weights and measures officers. It is stated in the memorandum of the draft regulations made under the provisions of Article 39 of the Ordinance that "The general aim is to provide in the Ordinance rigid principles, and in the Regulations, flexible laws that could be amended as the need arose or developed further without the need to have a new bill put before Parliament."

The Regulations here described have been drafted in consultation with the Attorney General and the Public Service Commission. They were called "The Weights and Measures Qualifications and Duties of Officers, Regulations 1957." They were passed by the Minister of Commerce and Supply in March 1957 and came into effect on May 15, 1957.

The major outline of the Regulations is as follows:

1. Entrance qualifications.

2. Qualifying course.

3. Duties of the weights and measures officers in the execution of their powers under the Ordinance.

The full text of the Regulations is given in Appendix A. A detailed syllabus for every subject has been drafted.

The Minister or the Under Secretary is not empowered to suspend or revoke a certificate of qualification given to any office under these Regulations. For the case of frequent misconduct in the execution of his duties, such provisions may be made provided that a recommendation to suspend or cancel the certificate is issued by a court of justice or discipline boards.

Future Training Policy

Recently a technical committee was formed by the Sudanese National Council for Higher Education. It has investigated and evaluated the performance of our weights and measures school with regard to:

1. Qualifying syllabus.
2. Training facilities.
3. Future development.

The committee was headed by the head of the engineering faculty of the Institute of Technological Colleges with other representatives. Their final report is receiving our careful consideration.

The recommendations are as follows:

1. The syllabus should be enlarged to include:

   a. Latest developments of trade weights and measures equipment.

   b. Study of office administration techniques.

   c. Expanded knowledge of legal procedures and study of any other new weights and measures legislation.

d. Advanced methods of calibration of standards and trade equipment.

e. Electricity and applied electronics.

f. Technical drawings and statistics.

g. Study of metals technology.

2. The term weighing and measuring practice should be altered to read "technology of weighing and measuring instruments" to widen the scope of training.

3. Entrance qualifications should be reviewed.

Appendix B outlines the available school training facilities.

Training Abroad

Qualified officers are selected from time to time for scholarships for studies concerning weights and measures in accordance with their academic qualifications and record of work.

Institute of Weights and Measures (WMI)

We have in hand a scheme to develop our weights and measures school to a technical weights and measures institute. The proposed scheme will broadly speaking take the form of:

1. Physical needs, such as:

   a. Erection of school buildings.
   b. Setting up of a library equipped with textbooks and references.
   c. Supply of technical equipment.
   d. Supply of furniture.

2. Staffing. (Lecturers, tutors, and instructors should have extensive training in the weights and measures field, whether obtained locally or abroad.)

3. Foreign consultants to help in the establishment of WMI.

The Sudan is seeking financial funds in local and hard currency in order to start the implementation of this scheme. Contributions from international organizations or agencies, either in the form of technical aid or financial assistance, would be highly appreciated.

APPENDIX A

WEIGHTS AND MEASURES REGULATIONS, 1957
(QUALIFICATIONS AND DUTIES OF OFFICERS)

In exercising the powers conferred upon him by Section 39 of the Weights and Measures Ordinance 1955, the Minister of Commerce and Supply hereby makes the following Regulations:

Qualifications of Officers

1. Persons who have completed their secondary education or who have passed the relevant public service examination shall be eligible for recruitment as weights and measures trainees.

Weights and measures trainees who have completed three years as approved trainees and assistant weights and measures officers who have completed five years approved service shall be eligible to take the departmental qualifying examination for appointment as weights and measures officers.

2. The qualifying examination, whenever held, will be held in March.

3. The syllabus for the qualifying examination shall include the following subjects, but may be altered by the Minister from time to time:

a. English (written and oral).
b. Arithmetic and mensuration.
c. Physics.
d. Weighing and measuring practice.
e. Law.
f. Oral and practical tests.

The passing standard will be 50 percent overall and 40 percent in a single subject. The minimum passing standard in oral and practical is 50 percent.

Duties of Officers

4. Each officer shall be responsible for the inspection of every trade and its premises within his charge at least once in every year.

5. He shall be responsible for properly maintaining his standards and equipment which shall at all times be in his custody. He shall regularly compare his standards with the area standards issued to him and adjust the same to agree exactly (Section 18).

6. He shall maintain a daily record of his inspection and verification work.

7. His records shall consist of:

a. Work diary.
b. Inspection rough notes.
c. Inspection records.
d. Verification records.
e. Records of standards book.
f. Register of traders.
g. Caution book and record of prosecutions.

8. An officer shall not reveal to any person any information that comes into his possession in the course of his duties or otherwise betray the confidence of his office.

9. An officer shall not show any favor to any scale maker or repairer or supplier of scales or weights or measures by making any recommendations to any trader.

10. Inspection visits will, as far as possible, be planned and carried out with an element of surprise. Surprise visits should not be confined to official working hours only but must be designed to take place when least expected.

11. It is the officer's duty to supervise the work of his assistants, bearing in mind that the officer cannot delegate to an unqualified assistant any of his own statutory duties (Section 26-3).

12. No prosecution should be initiated without obtaining written authority from headquarters; and the results of each prosecution, with a note of the defense, if any, should be rendered at the conclusion of the case. No authority from headquarters shall be required for the prosecution of persons under Sections 22, 31A, 37, and 38 of the Weights and Measures Ordinance.

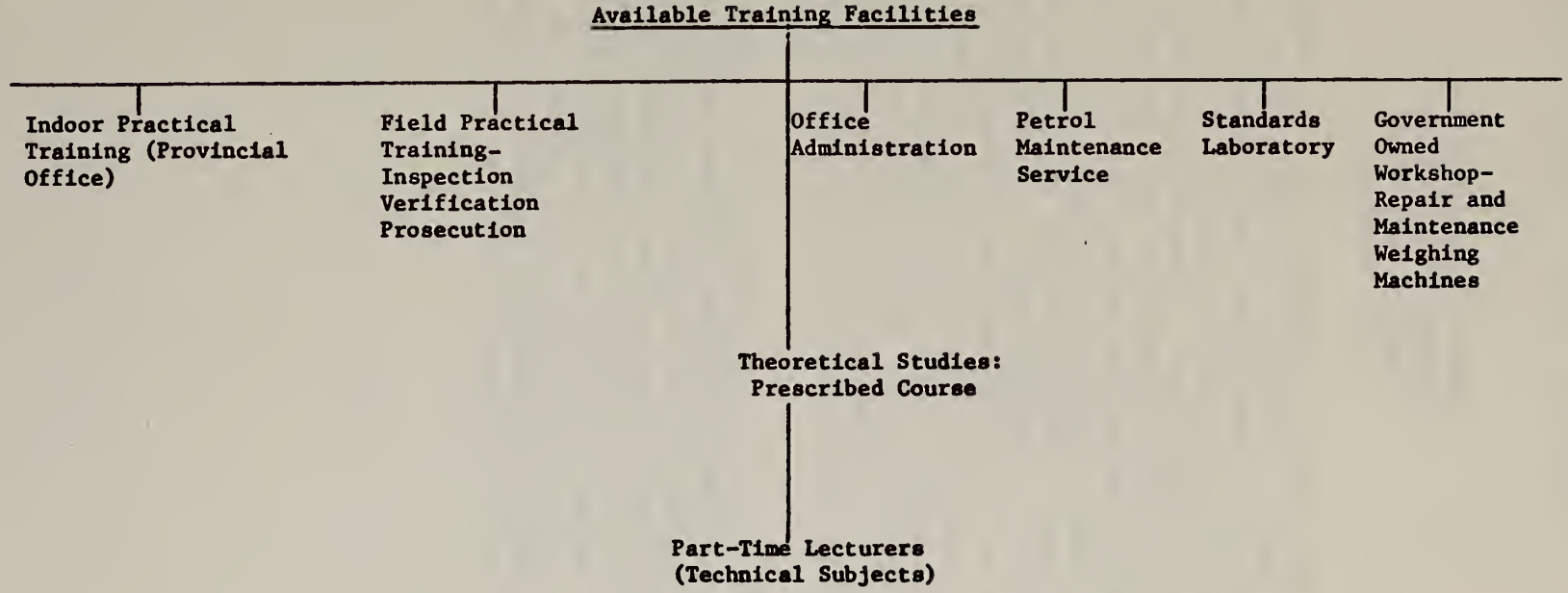
13. Every officer acting under Section 32 who seizes any weighing or measuring instrument or part thereof, shall give a receipt in writing for the same and shall, at the first opportunity, examine and fully test it according to the requirements of the relevant regulations in the presence of the owner.

The results of the test shall be sent to the Superintendent of Standards and the Magistrate if necessary in the form of a complaint. The appliance or an essential part of it should be produced before the Magistrate.

14. At the conclusion of every successful prosecution, the officer shall request the Magistrate to order the destruction of the article regarding which the complaint was made.

APPENDIX B

SCHOOL OF WEIGHTS AND MEASURES OFFICERS



CONTROL OF RETAIL MARKETS IN THAILAND

by

Mr. Wichian Pratoommas
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Royal Thai Embassy
New York, N.Y.

In Thailand, many ministries and independent agencies make measurements. For example, in the Ministry of Industry, we have the Department of Science with many test facilities and the Thai Institute for Industrial Standards with a number of capable committees representing industries and Government. The Ministry of Health has pharmaceutical and microbiological measurement capabilities, but it is the Ministry of Commerce that by law is responsible for the national measurement standards and the regulation of retail markets with a modest central office in Bangkok with substations in most provincial capitals. By comparison with U.S. state offices, the staff and equipment as yet are very modest, and the control of the thousands of traders with their measuring devices is not as effective as desirable. The consumer is more on the lookout for unfair treatment than his counterpart need be in the United States. So far the Government has not successfully insisted on the use of the metric measures, especially by farmers and wholesalers, although these measures alone are legal in Thailand.

I believe it is a function of the Government to protect the consumer in retail markets and hope that the Royal Thai Government should and will do more in this direction. Thailand has the technical capabilities in the universities, such as especially Chulalongkorn University, which could cooperate in training, and the United Nations or other countries could advise on the facilities needed. Just outside Bangkok is situated the Asian Institute of Technology which is ideally suited to assist. Graduate students could study the problem and suggest solutions which could be the subject of their theses.

SUMMARY OF THE ACTIVITIES OF THE OFFICE OF WEIGHTS AND MEASURES IN TUNISIA

by

Eng. Mohieddine Ben Larbi
Chief, Food Products Section
Central Laboratory
Tunis, Tunisia

The Office of Weights and Measures of Tunisia is concerned any time a commercial transaction involves the measuring of weights or lengths. Its action is based on several decrees:

1. The Decree of January 12, 1885, establishing the metric system in Tunisia.

2. The Decree of January 29, 1909, concerning the verification and construction of weights and measures, as well as weighing and measuring instruments.

3. The Decree of December 26, 1911, setting the value of the metric carat at 0.2 g.

4. The Decree of January 29, 1912, concerning the use of carat weights.

5. The Decree of May 10, 1930, concerning the general conditions for the verification and hallmarking of measuring apparatus.

6. The Decree of June 20, 1930, regarding the periodic utilization and verification of gas pumps.

In addition to the above decrees, the office also refers to foreign laws to complete its practices. Standard weights are obtained from Service des Instruments de Mesure de Paris (SIMP).

There are four permanent offices (Tunis, Sousse, Bizerte, and Sfax) working under the control of different regional offices whose task is to check all newly-constructed weighing and measuring devices. This check covers:

1. Precision.
2. Sensitivity.
3. Accuracy of measuring instruments.

Every imported measuring instrument must go through the permanent office for verification and initial hallmarking. The same is done with a locally manufactured instrument. The importer or manufacturer will pay a fee for this initial hallmark. The hallmark consists of a

letter of the alphabet stamped on the instrument which must be then periodically presented for a new check. It should be noted that each year a ministerial decree sets the length, the place, and the weight stamp letter for that year's verification of measuring and weighing instruments. The weight stamp letter is valid for all measures and weights and is changed each year. There are temporary offices, operating under the control of various permanent offices, that are responsible for these periodical inspections of weights and measures. Another task of the Office of Weights and Measures is to make sure that no "unstamped" weighing instruments ever go on the market.

As regards weigh-bridges (truck scales), the office sends its inspectors with standard weights to carry out a site inspection. Furthermore, it ensures control over tank capacity both for oil companies and the railway (tank cars). They also check on the accuracy of volumeters (water or gas companies, oil companies, etc.).

The Central Laboratory also ensures control over electric meters, both locally-made and imported. Some companies run their own weights and measures inspection services, as for example, the Societe Tunisienne d'Electricite et de Gaz (STEG).

The Central Laboratory is also responsible for inspecting meters used for the export of oil products. To carry out this task, the Laboratory has two engineers trained in two specialized institutions in the Federal Republic of Germany (Brunswick).

The Office of Weights and Measures in Tunisia will further extend the scope of its activities with additional staff and more specialized equipment. To that end, the assistance of the National Bureau of Standards/Washington has been requested, and a preliminary project is underway.

LAWS ON WEIGHTS AND MEASURES IN THE UNITED STATES

(during the 64th National Conference on Weights and Measures)

by

Mr. Allen J. Farrar
Legal Adviser
National Bureau of Standards

Your host, Mr. Steffen Peiser, has asked me to speak to you about the laws under which the National Bureau of Standards operates in the field of weights and measures. Before doing so, however, I should like to add my voice of welcome and to express the hope that you are enjoying your visit and are benefiting from your association with the other weights and measures officials at this Conference.

I know that if you are in the capable hands of Mr. Peiser, you are being well taken care of as he is the classic example of what an ambassador of good will should be. I was therefore quite flattered when he asked me to speak to this selected prestigious group. It is my understanding that Mr. Peiser has furnished you a copy of a talk concerning the Bureau's laws that I gave to the 60th National Conference on Weights and Measures.* I shall therefore limit my remarks to a few highlights of that earlier talk and give you an opportunity when I finish to ask me any questions that you may wish relating to the Bureau's legal authority in the area of weights and measures activities. In that way, I believe our informal get-together this evening may be interesting and productive for you.

The theme of my earlier talk--People Make the Difference--is as important in international dealings involving weights and measures activities as it is in our Federal-State relationship within the United States. If aid in this field of endeavor is to prove beneficial, it must be given willingly, it must be offered graciously, and it must be provided in a manner that is understandable and useful. The details on how such assistance may be provided to your country, if desired, by the United States are, of course, matters to be worked out between the appropriate officials in our respective countries in a spirit of mutual cooperation and friendship.

Any examination of the legal authority of the National Bureau of Standards in the area of weights and measures must begin with the Organic Act of NBS--an Act that was originally enacted in 1901. That

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*Farrar, Allen J., "The Perfect Formula and PMTD," pp. 123-33, Report of the 60th National Conference on Weights and Measures, 1975, NBS Special Publication 442, issued May 1976.

Act sets out the Bureau's general mission and provides the legal basis and authority for carrying out that mission. It is, in a sense, a charter which describes the nature and scope of the Bureau's activities, for whom it may perform those activities, and pertinent administrative requirements relative to carrying out its activities.

Two of the basic functions assigned to NBS under that statute which relate to weights and measures activities are:

(1) "The custody, maintenance, and development of the national standards of measurement and [providing the] means and methods for making measurements consistent with those standards, including the comparison of standards used in . . . commerce . . . with the standards adopted or recognized by the Government."

(2) "Cooperation with other government agencies and with private organizations in the establishment of standard practices, incorporated in codes specifications."

In carrying out those basic functions, the Bureau is authorized to undertake a number of specific activities in support of those functions. One of those supporting activities is:

"Cooperation with the States in securing uniformity in weights and measures laws and methods of inspection."

If I may return for a moment to the international aspects of weights and measures activities, I would point out that in 1972, the NBS Organic Act was substantially broadened. Before 1972, NBS was essentially limited to carrying out its functions for the Government of the United States, States and municipal governments within the United States, and other institutions, firms, and individuals within the United States. The 1972 amendment, however, enlarged the NBS authority so as to permit it to carry out its functions for international organizations of which the United States is a member, for governments of friendly countries, and for institutions, firms, and individuals in friendly countries. The exercise of the Bureau's functions in the international area, however, must be coordinated with the Department of State.

Possibly some of you may have noted in reading my earlier talk that there were a total of 20 Federal statutes that have been enacted over the years which assign specific scientific duties to NBS. You may be interested to know that in the intervening four years between that talk and now, an additional six statutes have been added to that total. One of those statutes which I believe would be of special interest to you is the Metric Conversion Act of 1975. That Act has taken on added significance recently in light of the problems caused by the steep increase in the price of gasoline and of the talks being carried out at this Conference involving the issue of converting

gasoline pumps from its present measurement system in terms of gallons to the metric system where the measurement would be in liters. The Act sets up a U.S. Metric Board to coordinate the voluntary conversion of the United States to the metric system. It is of interest to note that this Act was passed nearly 110 years after the Congress legalized the use of the metric system in the United States.

One aspect relating to the matter of the Bureau's legal authority that often is surprising to those who interact with NBS is the fact that not one of the 26 statutes which impose various responsibilities on NBS, including its Organic Act, confer any regulatory or enforcement powers on NBS. Hence, as NBS has no regulatory or enforcement powers, the way in which it carries out its authorized mission of developing the national standards of measurement, the establishment of standard practices for incorporation in codes and specifications, and securing uniformity in weights and measures laws and methods of inspection, is through cooperation. Up to now, the cooperative efforts exercised by NBS in the weights and measures field has largely been with other government agencies, private organizations, and the individual States. Hopefully, the level of cooperation which NBS has undertaken in the international field regarding weights and measures can be extended and broadened so that our knowledge and experience can be shared with all nations who desire to improve and upgrade the reliability and efficiency of their weights and measures activities and responsibilities.

I should like to conclude my remarks with a reference to the United States Constitution. As you no doubt realized during the past 10 days of your Course and especially at this Conference, the emphasis on weights and measures activities has been on the role played by the States in carrying out those activities. Some of you may find that strange in light of the provision in the United States Constitution that says "the Congress shall have the power . . . to regulate commerce . . . among the several states . . . and . . . to fix the standards of weights and measures."

The fact is, however, that although it has been more than 200 years since the United States was formed, Congress has done very little in the field of weights and measures.

In 1836, 60 years after this country issued its Declaration of Independence from England, Congress adopted a Joint Resolution which directed the Secretary of the Treasury to supply each state with a copy of weights and measures adopted as standards for the custom-houses. The purpose of that Resolution was to establish a uniform standard of weights and measures throughout the United States.

In 1866, Congress legalized the use of the metric system and ordered that each State be furnished a set of standards of the metric system. Finally in 1881, a complete set of all the weights and measures that

had been adopted as standards was ordered by Congress to be delivered to each State.

In 1966, NBS embarked upon a ten-year program to distribute to each of the States a completely new set of standards, precision balances, and laboratory instruments as replacements for the sets of standards and instruments originally authorized 130 years earlier. NBS recently completed that distribution.

Except for the Metric Conversion Act of 1975, which I mentioned a few moments ago, some minor Standard Barrel Acts of World War I vintage that are likely to be repealed if a survey, currently being considered, confirms our suspicion that they are being used very little, if at all, and the mentioned Joint Resolutions calling for the furnishing of sets of weights and measures adopted as standards to the States, Congress has not seen fit to exercise, to any substantial degree, its authority under the Constitution to establish weights and measures. Nor has it seen fit to vest that power in any Federal agency. What the Congress has done is to make plain its intention that a joint effort be made between the Federal Government and the States to establish a viable and effective weights and measures system.

We like to feel that NBS has been successful in establishing such a system by undertaking, as called for in its Organic Act in the portion I have cited earlier, namely:

> "Cooperation with the States in securing uniformity in weights and measures laws and methods of inspection."

I hope that my comments on the laws affecting NBS in the field of weights and measures has been helpful and that it may serve to facilitate your understanding of the various points set out in my earlier talk on this subject.

I would be very pleased at this time to answer any questions about any of the matters I have covered or about the various laws affecting the mission, purpose, and functions of the National Bureau of Standards.

EVALUATION AND CLOSING SESSION

by

Mr. H. Steffen Peiser
Chief
Office of International Relations
National Bureau of Standards

Mr. H. Steffen Peiser invited evaluation and criticism or elaboration of specific problems in the countries of the participants. He suggested that perhaps some would wish to relate their remarks to the papers that had been presented or to the evaluation sheets already submitted, for which Mr. Peiser expressed appreciation also on behalf of AID whose support for the NBS projects would be terminated. He pointed out that if any of the various NBS experiments for assistance to industrializing countries were judged to be successful, new mechanisms may be found. At this time, he noted, the Senate had defeated the proposed Institute for Scientific and Technical Cooperation (ISTC) but not without understanding the need for a more innovative approach which may yet be adopted by the U.S. Government in future years. (Very soon after the end of the Course, the ISTC was approved in a compromise between the Senate and the House of Representatives.)

Mr. Babiker Abu El Hassan then spoke of the benefit he had derived from this Course for planning the Sudan Government's new Institute for Metrology.

Mr. Albert D. Tholen, Chief of the NBS Office of Weights and Measures, joined the session briefly to invite guest workers to NBS from the organizations represented and to offer copies of NBS literature to all participants.

Mr. A.P.H.G. De Waas Gunawardena spoke of the expansion of the Institute of Sri Lanka Standards into fields of measurement technology beyond the mass, length, area, and volume concerns of most consumer retail markets. He had a special interest in collecting documents, catalogs, and information on electrical standard test procedures, as this was the next phase of development in the functions of this Institute.

Mr. Y. A. Balogun spoke of the division of the weights and measures authority in Nigeria from the Nigerian Bureau of Standards which reported to a different ministry.

Mr. J. Kiemue Kollie, as all other speakers, expressed his gratitude to NBS and AID with great sincerity. He requested NBS to issue certificates of participation. He compared favorably his experience in this two-week Course with six months' training he had received in

the U.S.S.R. He felt that the Course should have had more laboratory work and would be most useful to technicians rather than heads of laboratories.

Dr. Mohammed M. Ammar, on the contrary, felt that heads of laboratories alone had the width of knowledge and interest to appreciate most of these wide-ranging demonstrations.

Mr. Peiser thought that perhaps two different types of courses would be required, although technicians who should gain practical experience really needed months of practical experience in their specialties.

Dr. Debabrata Sen wondered how NBS had acquired such an excellent reputation. Was it lack of regulatory control or real technical excellence? In response, Mr. Allen J. Farrar, NBS Legal Adviser, thought that both these factors were involved.

Counselor Wichian Pratoommas thought the United States was leading the way in showing how the consumer could and should be protected.

Mr. Guillermo Rivera emphasized that Honduras has a growing manufacturing sector, and the metrological concerns of his Department were corresponding by growing in its fields of interest.

Dr. Julian Basurto welcomed the self-reliance which had been fostered by this Course.

Eng. Mohieddine Ben Larbi appreciated the help received even in his specialty of food processing control and was looking forward to supplementing this experience by visits to the Food and Drug Administration during the following week. He also remarked about the Course itself and said that it would be better for each one of the group to have more technical sessions in his own field at the end of the Course and gather information to exchange within the group.

Mr. Farrar summarized his impressions by praising the cooperative spirit of the participants and suggesting that the resources of NBS should be used selectively and thoughtfully to benefit development.

All agreed that the Course had been worthwhile and fruitful and had given much benefit and pleasure to the participants. Lasting friendships had been formed, and Mr. Kollie challenged all to keep it up by correspondence.

Then followed a discussion on Mr. Farrar's evening discourse on legal issues in regard to NBS and weights and measures control in the States of the Union (see p. 63). The question was raised about whether a weights and measures inspector, when he has discovered an infraction, should be expected to make a judgment of whether an intent to defraud existed or if only ignorance was involved. Mr. Farrar thought that on balance it was best to leave this judgment to the impartial courts of law.

Mr. Babiker's paper (q.v., p. 51), it was pointed out, had listed the parts of a good weights and measures ordinance. Mr. Farrar thought all of these were important except the interpretation, which could often be decided by the debates preceding the legislation or by reference to courts of law. Finally, the question was examined as to what extent transactions had to be strictly confined to legal units, standards, and certified instruments. The other extreme alternative was to make the vendor responsible under threat of prosecution to measure in terms of recognized units on instruments in tolerance, as laid down by a law.

EVALUATION OF THE NBS/AID COURSE
ON WEIGHTS AND MEASURES, 1979

A. RELEVANCE TO YOUR PROGRAMS IN YOUR COUNTRY

1. What portion of the presentations had any relevance to your

a. present needs?

AMMAR: Los Angeles Department of Weights and Measures, Rockwell International, and SPIE.

BALOGUN: All facets of the course.

BASURTO: Rockwell International, NCWM.

GUNAWARDENA: Metrication, check weighing of prepackaged goods, testing of gasoline pumps.

HASSAN: All presentations.

KOLLIE: Practical demonstrations in the mass laboratory at Rockwell.

RIVERA: Laboratory visits in Los Angeles.

SEN: Los Angeles Department of Weights and Measures.

b. future needs?

AMMAR: Fluke Manufacturing Co. and NCWM.

BALOGUN: Laboratory technology, calibration, packaging, NBS, and OIML.

BASURTO: Rockwell International, NCWM, Fluke Manufacturing.

BEN LARBI: Los Angeles Department of Weights and Measures, coffee plant, milk department, and fish market.

GUNAWARDENA: Training of weights and measures personnel, electrical standards, grain moisture measurement.

HASSAN: All presentations.

KOLLIE: Los Angeles Department of Weights and Measures.

RIVERA: Calibration system of Rockwell and Fluke.

SEN: Los Angeles Department of Weights and Measures.

and Fluke Manufacturing instruments and systems for electrical calibrations.

2. Which presentations could have been omitted

   a. at the Los Angeles Department of Weights and Measures?

   b. at Rockwell International?

   c. at Fluke Manufacturing?

   d. at the Society of Photo-Optical Instrumentation Engineers?

   e. at the National Conference on Weights and Measures?

   The group agreed, almost unanimously, that none of the above presentations could have been omitted.

3. Which presentations could have been expanded

   a. at the Los Angeles Department of Weights and Measures?

      AMMAR: Metrology laboratory demonstrations.

      BALOGUN: Practical test of bulk measuring instruments.

      BEN LARBI: All presentations.

      GUNAWARDENA: Examination of gasoline pumps.

      HASSAN: All presentations.

      KOLLIE: Practical demonstrations.

      RIVERA: Gas meter and taxi meter inspections.

      SEN: Methods of verification of large capacity weighing machines, volume measuring devices, and taxi meters.

   b. at Rockwell International?

      BALOGUN: Calibration of mass and balances.

      HASSAN: All presentations.

      KOLLIE: More laboratory visits and more practical demonstrations.

      SEN: More time at the metrological laboratory.

      All others felt the presentations did not need to be expanded.

c. at Fluke Manufacturing?

HASSAN: All presentations.

KOLLIE: Practical demonstrations.

SEN: Automated system for electrical calibration.

All others felt the presentations did not need to be expanded.

d. at the Society of Photo-Optical Instrumentation Engineers?

GUNAWARDENA: A visit to the laboratories would have been better.

All others felt the presentations did not need to be expanded.

e. at the National Conference on Weights and Measures?

BALOGUN: Packaging.

BEN LARBI: All presentations.

HASSAN: All presentations.

KOLLIE: Package inspection, prototype examination, national net weight policy, weights and measures in the United States.

SEN: The special lecture presentations.

All others felt the presentations did not need to be expanded.

4. Which presentation was most valuable for you

a. at the Los Angeles Department of Weights and Measures?

AMMAR: Visits to the retail marketplace.

BALOGUN: Setup and activities of a weights and measures office in the United States.

BASURTO: Market and packing visits.

BEN LARBI: All presentations.

GUNAWARDENA: Metrology laboratories, quality control, inspection of packaged goods.

HASSAN: All presentations.

KOLLIE: Practical demonstrations, factory, and supermarket tours.

RIVERA: Mass, volume, equipment.

SEN: Talks on different aspects of weights and measures activity.

b. at Rockwell International?

AMMAR: All presentations.

BALOGUN: Calibration of mass and balances, construction of a testing laboratory.

BASURTO: Purpose and development of Rockwell's metrology laboratory.

GUNAWARDENA: Metrology laboratories.

HASSAN: All presentations.

KOLLIE: Practical demonstrations, laboratory tours.

RIVERA: Equipment calibration.

SEN: Visit to length and pressure measurement laboratories.

c. at Fluke Manufacturing?

AMMAR: All presentations.

BALOGUN: Calibration of instruments by computers.

BASURTO: Devices demonstration and calibration laboratory.

GUNAWARDENA: Metrology laboratories and visit to manufacturing plant.

HASSAN: All presentations.

KOLLIE: Practical demonstrations, factory and laboratory tour.

RIVERA: Device demonstration.

d. at the Society of Photo-Optical Instrumentation Engineers?

AMMAR: All presentations.

BALOGUN: Job content.

BASURTO: Technical books.

HASSAN: All presentations.

RIVERA: Technical information.

e. at the National Conference on Weights and Measures?

AMMAR: All presentations.

BALOGUN: All presentations.

BASURTO: Standards and laboratories, legal aspects of weights and measures.

GUNAWARDENA: Standards and laboratories, legal aspects of weights and measures, packaged goods inspection.

HASSAN: All presentations.

KOLLIE: Package inspection, prototype examination, net weight policy.

RIVERA: Legal aspects of weights and measures.

SEN: Measurement sciences challenges, prototype examination.

5. What presentations could have been added?

BALOGUN: Present day developments in bulk purchasing instruments, testing of taxi meters.

BASURTO: Visit to NBS laboratories.

BEN LARBI: Prepackaging, real applications of control of weights and measures in the United States.

HASSAN: Short visits to NBS, gasoline pump manufacturers, scale manufacturers including maintenance and repair service. Practical demonstration of type approval for weighing and measuring instruments including requirements and examinations.

SEN: Some demonstrations of the methods of measurement. This was done only for mass and pressure at Rockwell International.

6. General comments on the overall benefits of this course to you and your country.

AMMAR: I greatly benefited from the course, especially the quality assurance program, the activities of the National Conference on Weights and Measures, the Fluke scope of production, and the publications of the Photo-Optical Society.

BALOGUN: The course has been highly beneficial, especially now that my country is about to build a laboratory for calibration and type approval. Meeting with different manufacturers for the purchase of testing equipment.

BASURTO: This course was well organized; with my country preparing to install new laboratories for metrology, all of the visits were beneficial for our purposes.

BEN LARBI: Getting to know the details of the American system of weights and measures is very interesting; it is possible to compare this system to the French system.

GUNAWARDENA: The Training Course was very useful and will benefit my country's future programs in weights and measures in expansion of its activities in the new fields of electrical measurement, measurement of moisture content in grain, and gasoline pumps.

HASSAN: This course will enable me to establish our Legal Metrology Laboratory which was approved in principle by the Sudan Government's six-year development plan. I have had the privilege of making the outlines for the project, and I look forward to having technical consultations with you. The other benefits are innumerable.

RIVERA: Devices knowledge, metrology laboratory organization, legal aspects of metrology.

SEN: The course has made me realize that professionally I am not a good metrologist, perhaps not a metrologist at all, and has shown me what I should do to become one. I do not know what the benefits will be to my country.

B. PERSONAL QUESTIONS

1. Did you

a. enjoy the course?

All answered yes.

b. regret attending the course?

All indicated no.

2. Did you profit professionally and technically?

All answered yes.

3. Do you feel you have established personal and useful contacts with the

a. NBS staff or state weights and measures officials?

All answered yes.

b. other U.S. colleagues from the States?

All answered yes except one person who replied no.

c. other U.S. colleagues from instrument industry or industrial standards laboratories?

All indicated yes.

d. other course participants?

All indicated yes.

4. Do you feel your country should have sent someone else of

a. greater position seniority?

Six persons answered no.

b. lesser position seniority?

Four persons indicated yes, and four no.

c. greater technical experience?

Two persons answered yes, three no.

d. lesser technical experience?

One person indicated yes, four no.

5. What suggestions would you make for the possible organizational arrangements of future courses?

AMMAR: The course was well designed and adequate for such purposes and in such a period of time.

BALOGUN: Visits to premises of weighing manufacturers, e.g., Toledo, Fairbanks, and measuring instruments for gasoline, e.g., Gilbarco. Some period within NBS very essential.

BASURTO: Initial meeting in order to discuss participants' papers.

BEN LARBI: It would be better if we had stayed at the same place to study several points. We can cover several subjects, and I think that we will have enough time.

GUNAWARDENA: Practical training will be very beneficial to participants, and the period of training should be extended for the presentations.

HASSAN: Please allow two or three days for personal interests.

KOLLIE: 1. The course should be more than two weeks. This will give participants time to do in-depth studies of their problems.

2. More practical examples should be included.

3. The participants should have a chance to stay at one location for at least a week.

C. OTHER COMMENTS

BALOGUN: The course should be stabilized to continue annually so that developing countries can acquire knowledge and experience from a country occupying a unique position like the United States. Present participants should be invited at least within the next two years for further reorientation and to know how far this present course has benefited them by way of practical application.

BASURTO: I offer my thanks and congratulations to Mr. S. Peiser and to Mr. C. Raley and the NBS staff for the organization of this course and for all their attention.

BEN LARBI: The organization of the course is very good; we have respected the time of the meeting. It is very beneficial to meet people from other countries.

GUNAWARDENA: I found the Training Course very useful and beneficial. It has exposed me to more sophisticated and advanced techniques in the field of weights and measures.

My sincere thanks and congratulations to Mr. Steffen Peiser, a genuine ambassador of good will, and to other officials of NBS for the excellent planning and scheduling of this program.

Also, I express my sincere thanks to the Americans for their warm welcome and hospitality.

HASSAN: In addition to my various technical and legal responsibilities, I have been assigned the responsibility of planning and implementation of development projects and schemes. This course will improve my planning and implementation capabilities. I have also expanded my knowledge of my profession. A lot of thanks to: (1) NBS, (2) AID, (3) all presentations, (4) to everybody who participated in the organization of this unique course. Special thanks to my friends Mr. Steffen Peiser and Mr. C. C. Raley. In fact, they looked after us carefully and patiently. Many thanks to my friend, Mr. Albert Tholen.

Again, thanks to the Americans for their hospitality. I look forward to future close cooperation between my Department, NBS, AID, and most of the manufacturers, suppliers, associations, organizations, etc., who participated in the 64th National Conference on Weights and Measures and in the presentations of the Training Course.

MOLLIE: The course as planned is quite in order. However, I would like to see in the future more emphasis on practical activities than visits. In my opinion, this will equip the participants to better understand their jobs. It may be even better if the participants could spend a week at NBS doing practical work. This will give them a chance to understand further the problems.

RIVERA: Thank you very much, Mr. Peiser and Mr. Raley.

APPENDIX I

NBS SPONSORED GROUP VISIT TO ROCKWELL INTERNATIONAL METROLOGY

SUMMARY OF

TECHNICAL PRESENTATIONS AND DEMONSTRATIONS

Technical presentations are given by senior members of the technical staff for each of six measurement subjects which are part of the measurement activities of this industrial metrology laboratory. These are:

1. Inductance and capacitance
2. Magnetics
3. Mass
4. Length
5. Pressure
6. Optics and Photometry

The presentations include demonstration of measurement and calibration setups. The objective of the presentations is to provide the attendees with a comprehensive overview of the nature and complexity of the work of this industrial metrology laboratory. Subjects of discussion include measurement environment, equipment used, the value of the measurement, the accuracies of measurement and traceability to national standards (NBS).

Participation of the attendees is encouraged. Questions, discussion and demonstrations are treated to the level of interest and to the extent allowable within the schedule.

Summaries for the individual courses are given in the following:

SUMMARY

INDUCTANCE AND CAPACITANCE

The measurement of precision capacitors and inductors and calibration of capacitance and inductance bridges are performed in a temperature controlled and EMI shielded laboratory. This is to minimize the effects of changes of value of standards due to temperature and extraneous electromagnetic and electrostatic fields.

The work performed in the laboratory supports the company's electronic research and product acceptance testing on all programs, since capacitance and inductance are two of the three basic passive electrical elements used in all circuitry.

The standards used are fixed values of capacitance and inductance, each having as much as 20 years of performance history. These values are periodically re-established by direct measurement of the standard by the National Bureau of Standards (NBS) and/or by an NBS supervised Measurement Assurance Program.

The accuracies attainable are as follows:

Capacitance (2 and 3 terminal)

0.001 pF to 1 μF, 50 Hz to 20 kHz	2 ppm to 5% of measured value
1 μF to 10 mF, 0-400 Hz & 1 kHz	0.1% to 1% of measured value

Inductance

50 μH to 50 mH, 100 Hz to 20 kHz	0.022% to 2% of measured value
100 mH to 5 H, 100 Hz to 3 kHz	0.022% to 0.2% measured value
1 H to 10 H, 65 Hz to 1 kHz	0.022% to 0.2% of measured value

Demonstrations:

Owen Precision Inductance Measuring System

Ratio Transformer Precision Capacitance Measuring System

Autonetics High Capacitance Measuring System

Calibration of Standard Capacitors and Inductors

Presented by: T. A. Samp

SUMMARY

MAGNETICS

Magnetic field measurement and calibration is performed in a shielded laboratory and provides traceability for the company's production test requirements on various inertial guidance systems, engineering research and development and transportation/shipping specifications.

Electronic guidance equipment is tested for susceptibility to magnetic fields. The earth's flux density is approximately 500 mG which makes these measurements difficult without special precautions and techniques.

Probe position is very critical in magnetic fields and special adapters and fixtures, made of non-magnetic materials, are used to obtain reliable measurements.

The standards and equipment calibrated are: magnetic flux density sources (Helmholtz coils, solenoids, standard reference magnets), flux density measuring devices (gaussmeters and magnetometers), flux generators and ballistic galvanometers.

The accuracies obtainable are:

Flux Density	±1% to 3% from 100 gamma to 2 Tesla
Flux	±1% up to 100 000 maxwells

Demonstrations

1. Standard magnet comparison
2. Magnetometer/gaussmeter calibration
3. Flux measurement

Presented by: J. L. Arther

SUMMARY

MASS

Mass calibrations are performed in laboratories in which the environment is carefully controlled. The actual temperature is not critical; however, it is necessary to provide stable temperature and humidity control and to minimize air velocity.

Mass standards are not based upon a natural phenomena. The international standard of mass is a well defined kilogram maintained in France near Paris. The United States and other countries have copies of this standard for their reference. Subsequent copies called prototypes are used to calibrate weights on a routine basis.

At Rockwell Metrology there are two prototype kilograms that have been compared to second level prototypes at the National Bureau of Standards. By various comparison techniques these are used as the starting standards for all of our mass calibrations which are part of a Measurement Assurance Program (MAP) with the NBS.

Calibration accuracies depend upon the quality of the weights but between 0.1 mg and 10 kg ≈1 ppm is attainable.

At Rockwell, the measurement of mass is needed for establishing weights of products down to the milligram level, for center of gravity measurements and in the analysis of component performance and characteristics by chemical analysis.

Demonstration.

Calibration of 1 kg weight with work sheets.

Presented by: L. H. Baker

SUMMARY

LENGTH

Length measuring standard ealibrations and measurement services are performed in laboratories with rigid environmental eontrols to maintain temperature as close to 20° C as possible (±0.25° C). Generally the length measurements made in this laboratory are stated in terms of the International ineh. However, eonversion to metrie is oceurring as dictated by new business.

A large variety of length measurements are performed. These range from profile measurement of submieron film thiekness to length measurement of parts and standards up to 40 inehes in length. A variety of geometrie subcategories of simple length measurement exist ineluding flatness, surfaee texture, roundness and angle.

In addition to traditional standards measurement, Metrology efforts include the design and development of speeial gaging and techniques for use in eritieal measurements whieh must be made in the produetion shop environment. Measurement services are performed to support problem solution work for engineering, quality assurance, production and receiving areas.

Standard artifaets with directly transferrable dimensions ealibrated by the National Bureau are not neeessarily used as referenees for eaeh measurement. Examples include the ealibration of gage blocks using interferometric subdivisicn and derivation of small angles using a laser angle generator and length standards. Some other items sueh as angle gage bloeks and line standards are submitted to the National Bureau of Standards as the most practical means of achieving the required aeeuracy.

Calibrations of gage bloeks are performed at referenee, transfer and working standard levels. Different methods are used for each level. A measurement Assuranec Program (MAP) is used to eontrol the quality of measurements. Laser interferometry is being adapted to the calibration of gage bloeks. The laser interferometer is useful in a variety of applications due to its long range (700 ft.) and high aeeuracy (up to 1 μin.)

Length standards come in a variety of shapes and sizes. The gage bloek is the most common and widely accepted. At the other extreme are specially designed artifacts of complex geometry which are used as masters in the comparison with production parts.

All length measurements are sensitive to environment and test eonditions. Among the factors whieh must be eonsidered are temperature, instrument and operator errors as well as a variety of error sources whieh are unique to speeifie measurements. Reference level measurements of dimensions of 0.4 inch or greater in this laboratory are made at a temperature which is controlled and/or known to ±0.25° C or better.

The accuracies attainable are as follows:

Gage Blocks 0 to 20 in	1 μin/ineh	Flatness 0-6 inehes	1 μineh
Line Standards 0 to 40 in.	20 μineh	6-20 inehes	2 μineh
Ring Gages 0 to 4 in.	5 μineh	Surface Texture 0-120 AA	2 μinch
Balls (Diametcr) 0-2 in.	3 μineh	Roundness 0-5 in.	1 μinch
Spherical Cavities	5 μineh	Angle 0-10 min.	0.1 sec
(Diametcr) 0-2 in.		even degrees	0.1 sec

Demonstration Subjeets

- Gage Bloek Measurement
- Line Standards
- Laser Interferometer
- Ring Gage Measurement
- Spherieal Rotor (Ball) Mcasurement
- Spherieal Cavity Measurement
- Optieal Flatness Measuremcnt
- Meehanical Profile Measurement
- Surfaee Texture Measurement
- Roundness Measurement
- Angle Measurement

Presented by: K. J. Lund

SUMMARY

PRESSURE

Pressure calibrations are performed in laboratories with the temperature and humidity controlled to reduce errors caused by environmental variations. The work performed in this laboratory supports testing for most of the programs in this company. The range of pressures for which calibration is required spans several different standards from 12,000 psi (82 x 10^6 N/m^2) to 10^{-7} Torr (1.3 x 10^{-5} N/m^2), a span of 11 decades.

The principal standards are

- Dead weight Piston Gauges -
  - liquid
  - gas
- Manometers
  - liquid column
  - compression - McLeod Gage
- Natural Physical Phenomena

All of the above are used in this laboratory plus the following·

- Servo type fused quartz gauges
- Capacitance Manometers
- Incline Manometers

Pressure measurements at Rockwell are used in the testing and control of processes. Vacuum measurements support the production of microcircuit elements and in support of gyro manufacturing.

Demonstration:

Calibrate Pressure Gage

Presented by: L. H. Baker

SUMMARY

OPTICS AND PHOTOMETRY

Optical and Photometric measuring standards and testing equipment are calibrated in laboratory areas painted with black 3M-Nextel totally absorbing paint. The illumination levels of these laboratories can be controlled to totally darken the work areas; a necessary condition for photometric work.

The photometric/radiometric work done in these laboratories supports the company's various sensor/seeker system product performance and quality testing, procurement quality testing and engineering research and development for establishing new product specifications.

The standards and equipment calibrated are: (1) Sources ranging from sophisticated pulsed Nd-YAG laser systems to light emitting diodes and tungsten filament bulbs, (2) detector systems ranging from complex spectroradiometer systems to simple solid-state photo sensitive materials and light meters. Optical elements and systems calibrated also include narrow bandpass filters, various types of reflective/transmissive windows and lenses, aspherical and spherical mirror testers and light collimators.

Calibrations are accomplished using a four by twelve foot table with a triangular steel optical bench mounted on it. The various elements of calibration system and the test object are mounted on the bench carriages and located as required for each calibration setup. The principles of the inverse-square-law are employed for setting energy levels. Wavelength areas are established using monochromators, Krypton Ion laser radiation lines, spectral lamp lines, narrow bandpass filters and absorbing elements.

The accuracies attainable are as follows:

Luminous intensity, luminance	2 to 5%
Spectral irradiance	3 to 5%
Spectral optical power	0.7 to 5%
Wavelength resolution	1 nanometer
Optical Density	0.05 O.D.

Demonstrations

1. Pyroelectric Calibration system for Sources and Detectors
2. Pulsed laser calibration system Nd-YAG
3. Light meter calibration system
4. Calibration System for Spectrophotometers
5. Various measurements related to calibration of optical elements - Filters, lenses and reflectors.

Presented by: J. A. Hall

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16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

During the period July 15-27, 1979, a course on weights and measures services was held by the National Bureau of Standards under the sponsorship of AID in Los Angeles, California; Seattle, Washington; and Portland, Oregon. The object of the course was to give weights and measures officials of industrializing nations insight into the weights and measures systems of the United States and the role of the National Bureau of Standards, so that these officials might consider what parts of the U.S. system might usefully be adapted to conditions in their home countries. An exchange of experience in each of the participant's countries was presented by delivered papers which are reproduced here. Countries represented included Egypt, Honduras, India, Liberia, Mexico, Nigeria, Sri Lanka, Sudan, Thailand, and Tunisia.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

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