NATIONAL BUREAU OF STANDARDS REPORT

10 551

PROGRAM OF LEGAL METROLOGY AND SCIENTIFIC METROLOGY
QUITO, ECUADOR

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards [1] was established by an act of Congress March 3, 1901. Today, in addition to serving as the Nation's central measurement laboratory, the Bureau is a principal focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. To this end the Bureau conducts research and provides central national services in four broad program areas. These are: (1) basic measurements and standards, (2) materials measurements and standards, (3) technological measurements and standards, and (4) transfer of technology.

The Bureau comprises the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, the Center for Radiation Research, the Center for Computer Sciences and Technology, and the Office for Information Programs.

THE INSTITUTE FOR BASIC STANDARDS provides the central basis within the United States of a complete and consistent system of physical measurement; coordinates that system with measurement systems of other nations; and furnishes essential services leading to accurate and uniform physical measurements throughout the Nation's scientific community, industry, and commerce. The Institute consists of an Office of Measurement Services and the following technical divisions:

Applied Mathematics—Electricity—Metrology—Mechanics—Heat—Atomic and Molecular Physics—Radio Physics [2]—Radio Engineering [2]—Time and Frequency [2]—Astrophysics [2]—Cryogenics.[2]

THE INSTITUTE FOR MATERIALS RESEARCH conducts materials research leading to improved methods of measurement standards, and data on the properties of well-characterized materials needed by industry, commerce, educational institutions, and Government; develops, produces, and distributes standard reference materials; relates the physical and chemical properties of materials to their behavior and their interaction with their environments; and provides advisory and research services to other Government agencies. The Institute consists of an Office of Standard Reference Materials and the following divisions:

Analytical Chemistry—Polymers—Metallurgy—Inorganic Materials—Physical Chemistry.

THE INSTITUTE FOR APPLIED TECHNOLOGY provides technical services to promote the use of available technology and to facilitate technological innovation in industry and Government; cooperates with public and private organizations in the development of technological standards, and test methodologies; and provides advisory and research services for Federal, state, and local government agencies. The Institute consists of the following technical divisions and offices:

Engineering Standards—Weights and Measures — Invention and Innovation — Vehicle Systems Research—Product Evaluation—Building Research—Instrument Shops—Measurement Engineering—Electronic Technology—Technical Analysis.

THE CENTER FOR RADIATION RESEARCH engages in research, measurement, and application of radiation to the solution of Bureau mission problems and the problems of other agencies and institutions. The Center consists of the following divisions:

Reactor Radiation—Linac Radiation—Nuclear Radiation—Applied Radiation.

THE CENTER FOR COMPUTER SCIENCES AND TECHNOLOGY conducts research and provides technical services designed to aid Government agencies in the selection, acquisition, and effective use of automatic data processing equipment; and serves as the principal focus for the development of Federal standards for automatic data processing equipment, techniques, and computer languages. The Center consists of the following offices and divisions:

Information Processing Standards—Computer Information — Computer Services — Systems Development—Information Processing Technology.

THE OFFICE FOR INFORMATION PROGRAMS promotes optimum dissemination and accessibility of scientific information generated within NBS and other agencies of the Federal government; promotes the development of the National Standard Reference Data System and a system of information analysis centers dealing with the broader aspects of the National Measurement System, and provides appropriate services to ensure that the NBS staff has optimum accessibility to the scientific information of the world. The Office consists of the following organizational units:

Office of Standard Reference Data—Clearinghouse for Federal Scientific and Technical Information [3]—Office of Technical Information and Publications—Library—Office of Public Information—Office of International Relations.

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.
[2] Located at Boulder, Colorado 80302.
[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

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PROGRAM OF LEGAL METROLOGY AND SCIENTIFIC METROLOGY QUITO, ECUADOR

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NATIONAL BUREAU OF STANDARDS

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INTRODUCTION

In Ecuador as in all countries of the world, measurements are made at every level of trade and commerce; in the purchasing of raw materials, during manufacturing processes, distribution, and in the sales to users. In agricultural production, manufacturing, importation and exportation, and at the final consuming level, accurate measurements are essential so that buyer and seller receive just compensation for goods and services. This is of particular concern in industrializing countries.

An effective program of metrology includes the basic law and regulations, primary reference standards, secondary laboratory standards, field standards, capable administrators and well-trained laboratory and field personnel. These elements must be coordinated so that the industry, agriculture, the national government and the general public have confidence in the nationwide measurement system.

PART I

PROGRAM OF LEGAL METROLOGY

1. Objectives

The program objectives include the enactment of a law of legal metrology for the Republic of Ecuador, the development of a functional organization, and procurement of necessary physical standards of mass (weight), length, and volume. Together, these ingredients will be used to build a ten year program permitting gradual conversion to the Metric System regulatory control of commercial weighing and measuring equipment and packaged commodities.

Program objectives can be achieved only through effective enforcement of the law. The goals should include:

a. Uniform system of weights and measures in use throughout the country.

b. High level of accuracy in commercial measurement.

2. Program Description

The first priority is the enactment of a national law for metrology. The law will establish the units of weights and measures, the primary reference standards, and the authority for inspecting and testing packages and commercial equipment (Reference 1). At this time, reasonable regulations should be adopted that set forth performance requirements for commercial weighing and measuring devices (Reference 2) and for packages (Reference 3).

The second priority is the establishment of the Laboratory for Scientific Metrology. The Laboratory will serve as the measurement center for Ecuador and will house the National Reference Standards. All field standards used in law enforcement activities (testing of scales, meters, etc.) shall be traceable to the National Standards, and the National Standards to the International Standards held in Paris, France. (The program and organization for the Laboratory for Scientific Metrology are presented in Part II).

The third priority is to establish an organization with personnel to enforce the law and regulations.

It is proposed that the program of legal metrology be implemented in two 5 year stages, recognizing the conditions that exist: very little effective enforcement, and the existance of many traditional and foreign units in the market place.

First Stage (1-5 years)

a. Enactment of the Law and Regulations.

b. Establishment of the Laboratory of Scientific Metrology.

c. Establishment of Department of Legal Metrology.

d. Training of Director and Deputy Director.

e. Procurement of field standards and test equipment.

f. Limited program of Law Enforcement.

g. Extensive educational program.

h. Initial conversions to the Metric system.

Second Stage (6-10 years)

a. Additional field personnel.

b. Procurement of additional field standards and test equipment.

c. Expansion of law enforcement program.

d. Packager and device owner-operator responsible for accuracy under the law.

e. Completion of conversion to the Metric System.

3. Law and Regulations

The recommended law establishes the units of weight and measure to be used in commerce in Ecuador, and sets the standards that are to serve as the National Reference Standards. All commercial transactions should be traceable to the National Reference Standards through accurate weighing and measuring equipment tested with certified field standards. (If the chain of accuracy (reference) is broken, very little is known about measurements).

Performance requirements for commercial weighing and measuring equipment are well established and are appropriate for most metric weights and measures.

An important regulation is the Registration of Service Companies and Mechanics. (Reference 4). This provides for the installation and maintenance

of commercial equipment by authorized service companies and personnel only, and prohibits service by unqualified mechanics with inadequate and inaccurate test weights and measures. All test weights and measures used by service personnel must be approved annually by the Laboratory for Scientific Metrology (INEN). Incompetent service is ground for the revocation of a license.

The regulation pertaining to packages is important to the standarizatio of packaging and labeling. In addition, standards should be established for sizes of consumer packages on an individual product or product category basis. Standard package sizes enable the general public to make value comparisons when unit prices are not displayed, and negates the necessity for packagers to compete on a quantity basis.

In summary, the law and regulations should include:

a. Basic Law for Legal Metrology (Reference 1)

b. Regulation for Commercial Weighing and Measuring Equipment (Reference 2)

c. Regulation for Packaging and Labelling (Reference 3)

d. Regulation for Registration of Service Companies and Mechanics (Reference 4)

Procedures for checking packages for net content are found in NBS Handbook 67 (Reference 5) and should be used by the official in the testing program. This procedure provides for variations in packaged quantities and establishes a standarized sampling procedure and testing technique.

4. Organization

The Department of Legal Metrology should be part of the Ministry of Production, with complete responsibility for the enforcement of the National Law.

The staff for the Department consists of a Director, Deputy Director, and field personnel: Field Metrologist I (Trainee) and Field Metrologist II.

The Director is responsible for the administration of the over-all program: the hiring of personnel, allocation of resources, and the broad program of public education.

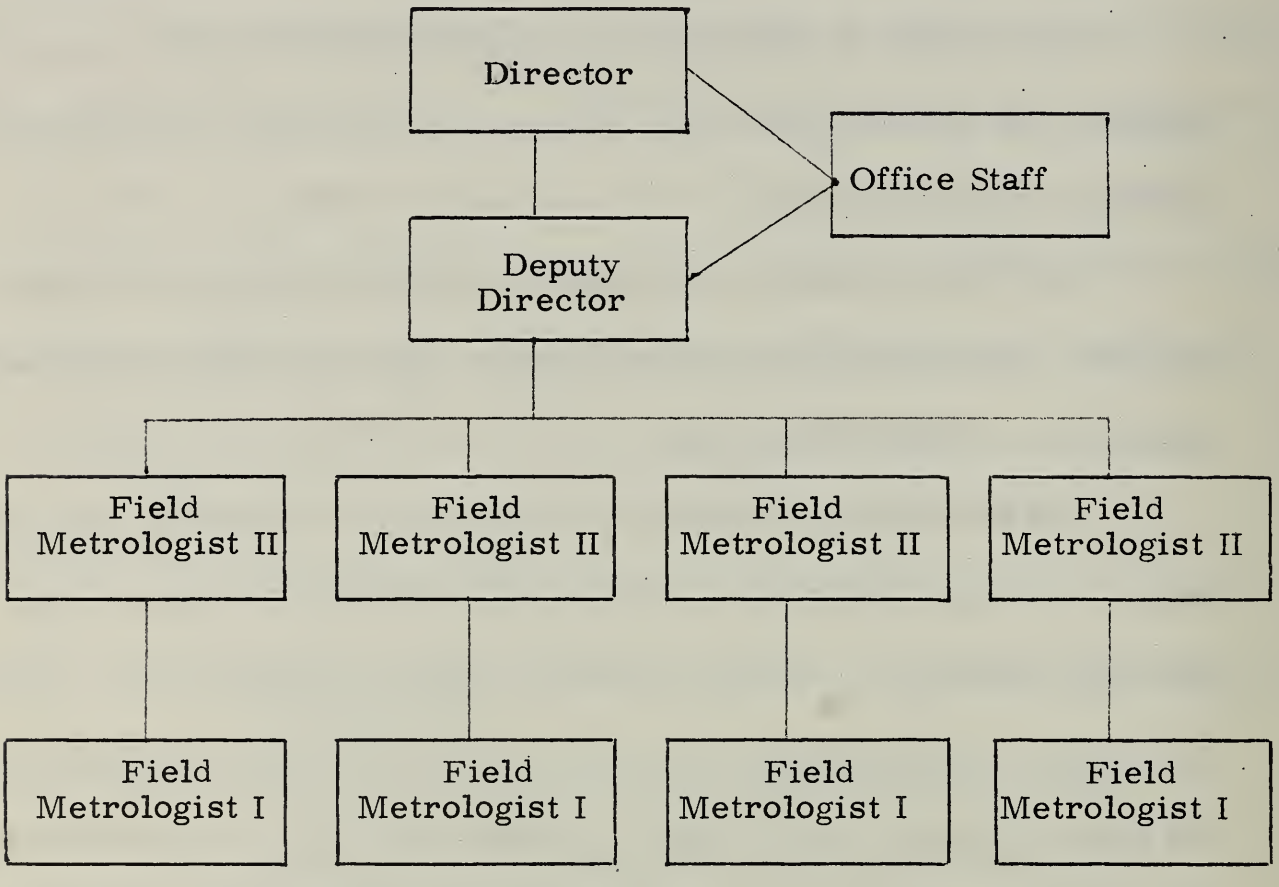
The Deputy Director is responsible for coordination of the enforcement program, conduct of special investigations, technical training and general supervision of field metrologists.

The Metrologist I (Trainee) position should be filled by graduates from a technical high school. Because of the technical nature of legal metrology the period of training should be not less than one year. During this period, the Metrologist I should work under the close supervision of the Deputy Director and an experienced Metrologist II. It is understood that, qualified personnel are attracted by good salaries and challenging positions; consequently, the salary scale must be sufficiently attractive for trainees to provide long term job stability. (Four years of on-the-job training is required in most cases for the development of a technically competent, professional field metrologist).

Metrologist II is a position for well qualified field personnel who have completed the basic training. A Metrologist II works under the general

supervision of the Deputy Director; yet, can perform his duties while using independent judgment, in keeping with the law, regulations, and departmental policy.

In addition to the professional staff, the Department will require a supporting office staff for stenographic assistance, i.e., typing, filing of reports, etc.



5. Personnel Development

The Director and Deputy Director should receive training at the National Bureau of Standards and at State weights and measures departments in the U.S.A. A period of six months should be considered for the study of weights and measures administration and technical aspects of commercial device testing and package control.

Following this six month period, four Metrologist I field personnel should begin training in Quito under the supervision of the Deputy Director. Initial instruction should include the law, regulations, and test procedures. During the first six months of the training period for metrologists all field testing should be under close supervision of the Deputy Director. Upon completion of the first year, four additional Metrologists I should begin training following a similar program of instruction given the previous group. Metrologists II can provide assistance in field training.

Following the first year training program, technical education should be planned on an annual basis and involve not only metrologists but also weights and measures industry--service company personnel, such as scale and meter mechanics, and packaging industry representatives. A five day program will provide considerable technical information and create a cooperative atmosphere between industry representatives and Department personnel and certainly an increase in understanding of program requirements and objectives.

6. Field Standards and Test Equipment

At the beginning of the training period for Metrologists I, each person should be equipped with a set of field standards which include the following:

Mass Standards

20 kg, cast iron, 6 ea. NBS Class F

Set, 22 wts., 1 kg to 500 mg NBS Class F

Package checking scale, 10 kg capacity

Length Standards

Steel tape, 30 M x 1 mm

Tape Rule, 3 M x 1 mm

Volume Standards

Field Standard Measure, 20 liters, adjustable scale

Field Standard Measures, flasks, 1 liter to 10 ml

With effective coordination of the testing program it may be possible to exchange field standards between metrologists so that complete sets are not necessary in every instance, particularly after the staff has grown to eight metrologists and after some have developed specialties such as package checking, meter testing, large scale testing, etc. It should be remembered that the metrologist is responsible for his standards and their maintenance, and that accuracy and appearance of field standards are paramount to a successful legal metrology program.

After the program's second year the addition of large test equipment should be considered. The testing of commercial devices may include flow meters and medium capacity dormant scales. For these devices, special test equipment and standards are necessary:

Prover, 400 liter capacity, adjustable reading scale, pump return, trailer mounted.

Test Truck, 2500 kg capacity, ten 250 kg field standard weight, cart hoist

At the end of five years, arrangements should be made for the purchase of a large capacity scale test truck. This truck carries a 10,000 kg standard weight load in 1,000 kg units, and is used for testing vehicle scales and other large capacity scales. The use of standard weight test loads to 10,000 kg, and greater is imperative if weighing is to be accurate at high capacities.

A cost estimate of these standards and test equipment will be furnished by NBS upon request.

Another important consideration is transportation for the professional staff. The Director, Deputy Director, and each metrologist should have a vehicle for transporting standards and equipment, and for mobility that is essential in weights and measures law enforcement. The coordination of tests and the requirement for efficient use of man power and equipment make the availability of vehicles a high priority consideration.

The maintenance of standards and test equipment must be a regularly budgeted item. Repairs to equipment, including painting and general maintenance, should be conducted on an annual basis, or more often as necessary. In addition, all field standards must be returned at least annually to the Laboratory for Scientific Metrology for recalibration and certification. This is required by the Law for Legal Metrology.

7. Public Education

The Director will be in charge of a broad program of public education to run concurrently with the first and second five year programs of legal metrology. Every level of government, industry and the general public should benefit from an intensive and extensive information dissemination effort and should receive publications explaining the new law, metric system and program of legal metrology. Television, newspapers, and radio are effective media for the dissemination of public information.

Industry, manufacturers, packagers, commercial equipment owners and operators should be made aware of the benefits of legal metrology and also of their responsibilities under the law. Meetings with business and industry representatives are helpful in the effort to gain general acceptance of the program of legal metrology--to transcend from "educational-enforcement", or service program, to a law enforcement program where the device owner or operator is responsible for the accuracy of the equipment. An effective educational program can result in the smooth evolution of legal metrology.

8. Program Progression

Following enactment of the Law for Legal Metrology and initial training period for the Director and Deputy Director, a limited law enforcement program should be undertaken that serves two primary functions: 1) Technical training for the metrologists; and, 2) educational information for the equipment owners, operators and service personnel.

Gasoline pumps and small capacity scales should be the first classes of devices to be tested. They are readily available in the large urban areas and are clearly visible by the public. Owner-operator responsibility for device accuracy should be emphasized. Following the educational service program, commercial equipment found to be inaccurate to the advantage of the owner (seller), should not be permitted to continue in operation until repaired or adjusted.

A package checking program can also be included in the early stages of the testing program. Random packaged quantities of foods prepared for sale in the super market can be checked for net weight. Food and non-food packages prepared by industry usually uniform in quantity of contents, can be tested at the factory or packing house.

The next category of equipment to be tested should include medium capacity portable and dormant scales. These are in wide use and range in capacity from approximately 500 kg to 2,500 kg.

As the staff is increased and as other resources become available other areas of enforcement should be administered. In the selection of areas for law enforcement and inthe establishment of priorities, economic impact of the testing program should be the primary consideration.

PART II

PROGRAM OF SCIENTIFIC METROLOGY

1. Location

The Laboratory for Scientific Metrology is located at INEN (Instituto Ecuatoriano de Normalización) and provides the necessary controlled environment for the maintenance of the Primary Reference Standards of Ecuador and other standards and instruments employed in precise calibrations and tests. (Reference Metrology Laboratory Drawing).

2. Standards and Instruments

The standards and instruments include primary standards of mass, length, volume, precision balances, and other equipment used in metrology. (Reference List of Standards).

3. Laboratory Services

The first objective of the metrology laboratory program is the establishment and maintenance of the Primary Reference Standards of Ecuador, In addition, the laboratory provides measurement services to government, universities, commerce, and industry at a practical level--to satisfy the requirements of quantity and quality control in production, inventory control, accuracy of manufacturing tolerances, etc. The standards provide the legal reference for contracts based upon weight and measure, and serve as the basis for commercial transactions--including imports and exports--at all levels of production and distribution.

4. Personnel

The laboratory staff includes a Laboratory Metrologist and Technologi The Metrologist, in addition to calibration and general laboratory administrativ responsibilities, provides metrological assistance and consulting services to government agencies, universities, business, commerce, and industry. The Technologist conducts tests and calibrations at the direction of the metrologist he is well qualified in the employment of acceptable techniques in the care and maintenance of primary standards and laboratory instruments.

5. Technical Training

The Metrologist and Technologist are to receive training in Basic Laboratory Metrology (80 hours), at INEN, at the time of installation of standards and instruments. At the completion of the basic study, the Metrologi and Technologist will qualify for training in Intermediate Laboratory Metrology (40 hrs) conducted at INEN or at the National Bureau of Standards (NBS), Washington, D.C. Advanced Metrology is available at NBS each year in two or three week programs. Participation in the advanced program of continued study should be considered upon completion of the intermediate level of instruction. (No fees have been established for training at NBS).

6. Laboratory Auditing Program

The Office of Weights and Measures at NBS conducts a Laboratory Auditing Program (LAP) designed to monitor standards, instruments, laboratory

environment, laboratory techniques and procedures; this also serves as a means for continued professional development of metrologists and technologists. Thirty state metrology laboratories cooperate in LAP and it is recommended that INEN participate also. (No fees have been established for participation). Through the exercises (laboratory problems) current calibration of standards is maintained and performance of instruments evaluated. Participating laboratories receive a "certificate" from NBS attesting to the traceability of standards and participation in LAP. Satisfactory participation--qualification for a "certificate"--consists of the completion of six exercises at the local metrology laboratory per year (1 every 2 months) and regular submission of data to NBS. The NBS evaluation and recommendations are sent by mail to the participating laboratories. Enrollment in LAP is on an annual basis.

7. Metrology Laboratory Program Expansion

The development of the basic standards program should follow in this sequence:

a. Laboratory facility--all construction should be completed prior to installation of any standards or instruments.

b. Installation of Standards by NBS--all installations to be supervised by NBS engineer.

c. Basic laboratory Metrology--training of Metrologists and Technologist in basic laboratory techniques and procedures at the time of standards installation.

d. Laboratory Auditing Program--INEN enrollment in LAP.

e. Intermediate Laboratory Metrology--forty hours training, at INEN or NBS, in more advanced calibration techniques and computations.

f. Advanced Laboratory Metrology--conducted at NBS laboratories, two to three weeks, of continuation studies.

g. New measurement capability--expansion into new measurement areas; ie. temperature, gage blocks, etc.

8. Specifications for Metrology Laboratory Environment

a. Temperature

Temperature control: 20° C ± 1° C

b. Vibration

Provide isolated footings (at floor level) for the 30 kg balance, Russell Balance, and balance table.

c. Air Flow

Air flow control: If used, air conditioners should be equiped with adjustable leuvers to control direction and quantity of air flow.

d. Relative Humidity

Maximum relative humidity 50%.

e. Illumination

Illumination: 100 foot candles at bench height

f. Dust Free Conditions

Cracks around doors to be sealed. Provide vinyl-asbestos floor tile

g. Access

Provide locks for Metrology Laboratory doors. Access to laboratory should be limited to the Director, Metrologist, and Technologist.

h. Standards Display

Provide a dust-free cabinet for mass standards, glass front, shelves 4.0 M (linear) x 0.40 M. (See laboratory drawing). Cover shelves with lint-free, soft material.

9. Standards and Instruments Specifications

Mass Standards

a.	30 kg to 1 mg in 5-3-2-1 series, 1 kg and 1 mg duplicated (33 wts.)	Stainless steel, 8.0 g/cm^3 density, austenitic, vacuum melted, non-magnetic (wts. 10 mg and smaller of Nichrome).
b.	200 kg, stacking; lifter rod, extender rod, eye bolt (2 each)	Stainless steel, type 303
c.	Field Standards, 1 set; 2 1-kg, 10-500 g; 1 each 250 g, 100g, 50g, 30g, 20g, 10g, 5g, 2g, 1g, 500 mg	Stainless Steel, type 303. (500 g aluminum) Adjust to NBS Class F tolerances.
d.	Field Standards 20 kg, 12 ea	Cast Iron, adjusted to NBS Class F tolerances
e.	Tare weight set, stainless steel type 303; 1 kg, 500 g, 300 g, 200g, 100g, 50g, 30g, 20g, 10g, 5g, 3g, 2g, 1g, 500 mg	NBS Class F
f.	20 g, capacity, single pan, constant load, direct reading	Precision 0.002 mg
g.	160 g capacity, single pan, constant load, direct reading	Precision 0.02 mg
h.	1 kg capacity, single pan, constant load, direct reading	Precision 0.2 mg

i.	30 kg capacity, single pan, constant load, direct reading	Precision 2.0 mg
j.	500 kg capacity, equal arm Russell Balance	Precision 1.0 g at capacity
k.	Field Balance, package checking, equal arm, 5 kg capacity	Precision 250 mg

Length Standards

l.	Steel Rule, 30 cm x 0.5 mm	Accuracy 0.01 mm
m.	Steel tape, 7 M, dm to I M, engraved graduations, 15 cm blank first end	Accuracy 0.08 mm
n.	Length Bench, 5 M x 1 M, stainless steel, type 416 accesories	Accuracy 0.15 mm
o.	Microscope, 20 X, 5.0 mm x 0.025 mm optical scale	Accuracy 0.001 mm
p.	Tension weights, 5 kg, stainless steel, type 303	NBS Class F
q.	Steel tape, 30 M x 1 mm, 15 cm blank first end	Accuracy 0.5 mm
r.	Tape Rule, 3 M x 1 mm, adjustable end clip at zero	Accuracy 0.25 mm
s.	Micrometer	

Volume Standards

t. Automatic Pipets boro-silicate
3 l, 2 l, 1 l, 300 ml, 200 ml, 100 ml
(All sizes minus 5-10 ml)

u. Automatic Buret, boro-silicate; 50 ml, 10 ml, (0.1 ml graduations) — Accuracy 0.01 ml (10 ml buret)

v. Twenty Liter Standard, slicker plate, stainless steel, type 303 — Accuracy 1.0 ml

w. Plastic Jars, reservoir for distilled water, 4 each, 5 gallon capacity

x. Accesories for pipet-buret assembly aluminum rack, rubber tubing, clamps, connectors, thermometers etc.

y. Test Measures, adjustable scale, 20 liter (5 gallon), low carbon steel

z. Test Measures flask, boro silicate 1 liter, 500 ml, 200 ml, 100 ml, 50 ml, 10 ml cylindrical graduate.

10. General Laboratory Equipment

a. Hoist, hydraulic, 1000 kg capacity, mobile

b. Water heater, electric, 20 liter capacity

c. De-humidifier, control relative humidity (50% maximum) 2 each

d. Heater, electric, portable, control laboratory temperature (20° C ± 1° C) 2 each

e. Miscellaneous equipment, ie., hammers, cutters, screw drivers, pliers,, drill, files, etc.

11. Standards and Equipment Costs * (Approximation)

a.	Mass Standards 30 kg to 1 mg	$ 7,000
b.	Mass Standards two 250 kg wts.	3,500
c.	Field Standard weights and measures	2,500
d.	Precision Balances 20 g 160 g, 1 kg, 30 kg	21,000
e.	Length Bench and Accesories	5,000
f.	Standard Steel Tapes	800
g.	Pipet-Buret Assembly	2,500
h.	Russell Balance, 500 kg capacity	4,500
i.	Misc. Equip. (Heaters, de-humidifiers)	2,000
j.	Training, NBS	3,000
	TOTAL	$51,800

*All cost estimates include calibration, shipping, and installation.

12. Purchase Priority Recommendations

a. First Priority:

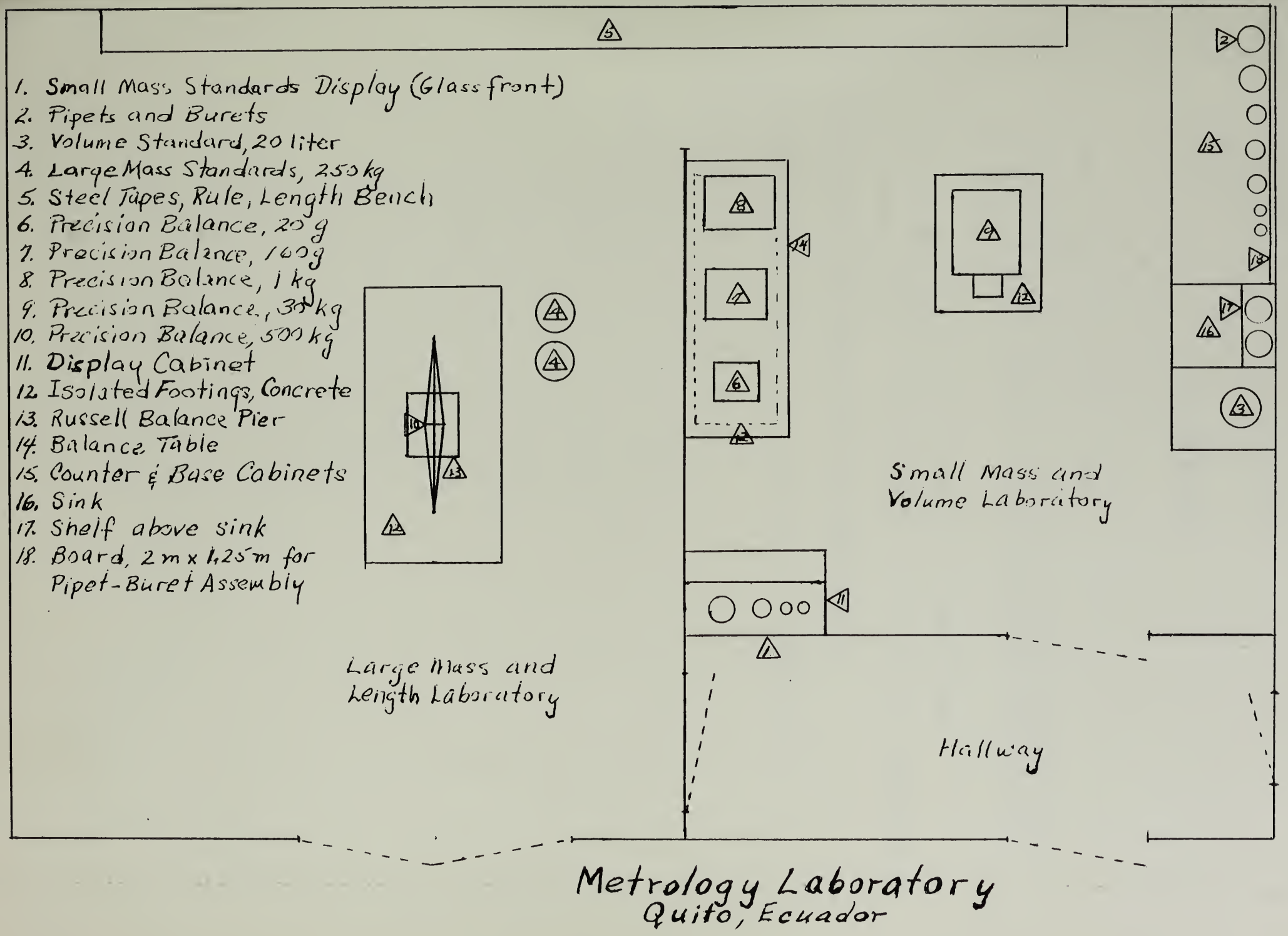
Small Mass Standards	$ 7,000
Field Standards	2,500
Precision Balances	21,000
Steel Tapes	800
Pipets - Burets	2,500
Misc. Equip.	2,000
Training and Installation by NBS	3,000
	$38,800

b. Second Priority

Russell Balance	$ 4,500
240 kg Mass Standards	3,500
	$ 8,000

c. Third Priority

Length Bench and Accesories	$ 5,000


1. Small Mass Standards Display (Glass front)
2. Pipets and Burets
3. Volume Standard, 20 liter
4. Large Mass Standards, 250 kg
5. Steel Tapes, Rule, Length Bench
6. Precision Balance, 20 g
7. Precision Balance, 160 g
8. Precision Balance, 1 kg
9. Precision Balance, 30 kg
10. Precision Balance, 500 kg
11. Display Cabinet
12. Isolated Footings, Concrete
13. Russell Balance Pier
14. Balance Table
15. Counter & Base Cabinets
16. Sink
17. Shelf above sink
18. Board, 2 m x 1,25 m for Pipet-Buret Assembly
Large Mass and Length Laboratory
Small Mass and Volume Laboratory
Hallway
Metrology Laboratory
Quito, Ecuador

REFERENCES

1. Law For Legal Metrology (INEN)

2. Specifications and Tolerances and Other Technical Requirements for Commercial Weighing and Measuring Devices, NBS Handbook 44 (NBS)

3. Model Packaging and Labeling Regulation (NBS) (INEN)

4. Licensing of Service Companies and Service Personnel (NBS) (INEN)

5. Procedures for Package Checking (NBS) (INEN)

6. Photographs of the Standards and Instruments (NBS) (INEN)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