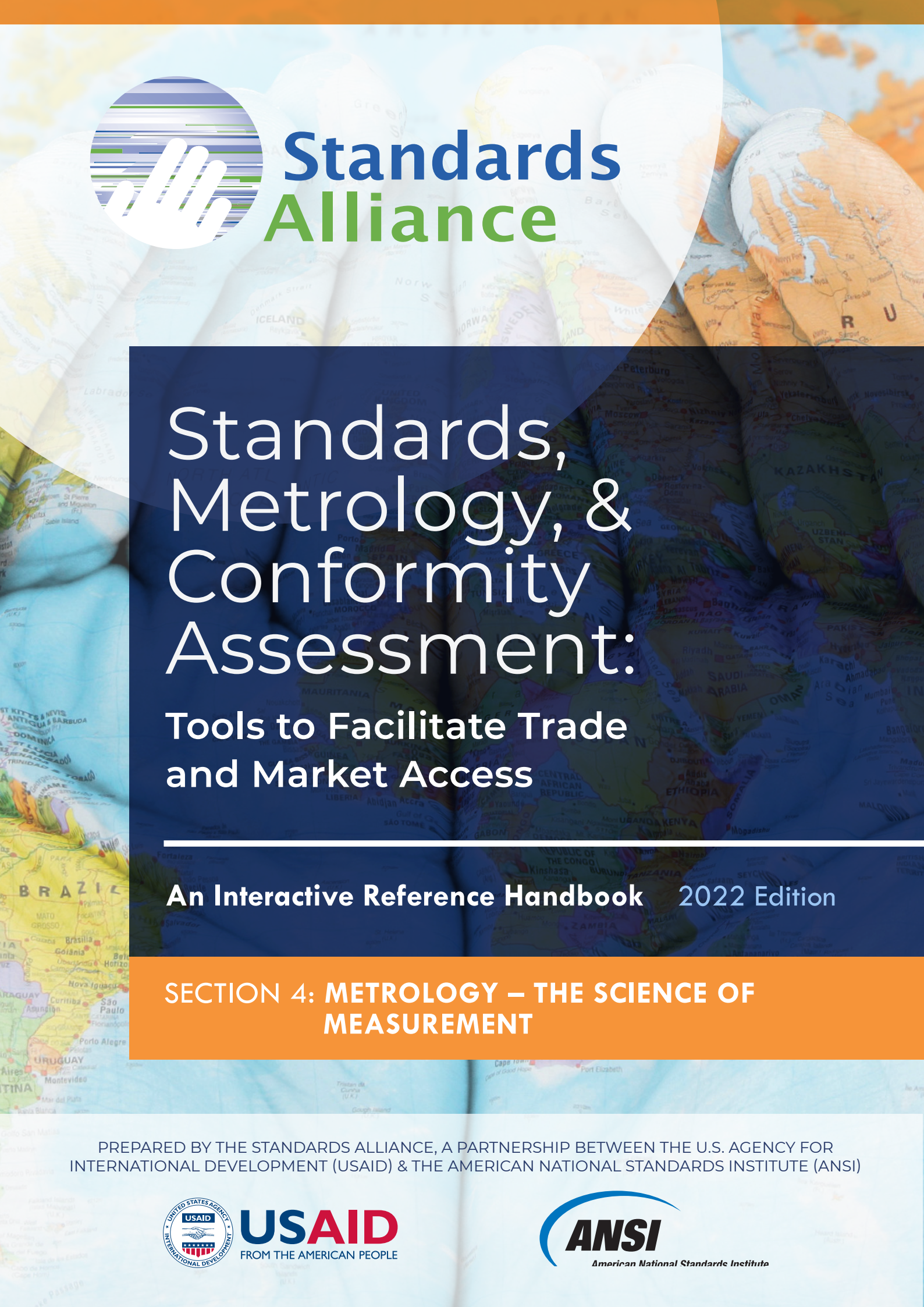


Standards Alliance

Standards, Metrology, & Conformity Assessment:

Tools to Facilitate Trade and Market Access

An Interactive Reference Handbook 2022 Edition

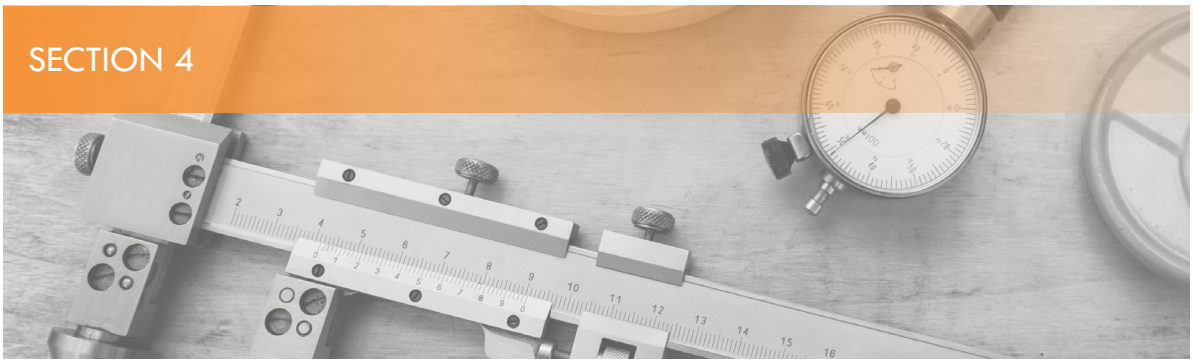
SECTION 4: **METROLOGY – THE SCIENCE OF MEASUREMENT**

PREPARED BY THE STANDARDS ALLIANCE, A PARTNERSHIP BETWEEN THE U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID) & THE AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

USAID FROM THE AMERICAN PEOPLE

ANSI American National Standards Institute

SECTION 4



METROLOGY

THE SCIENCE OF MEASUREMENT

WHAT IS METROLOGY?

Metrology is the science of measurement; it has been stated that the basic necessity of a trading system is metrology. Without the ability to determine length, weight (mass), volume, time, and temperature, even the simplest of transactions would be open to abuse, fair trade would be impossible, and legislation aimed at protecting the health and welfare of citizens would be of no effect. No technical standards could exist for products because there would be no reliable means of measurement of their performance against requirements. A national measurement or metrology system is therefore the first step in economic development and facilitating trade.

The Bureau International des Poids et Measures (BIPM – the International Bureau of Weights and Measures) defines metrology as "the science of measurement, embracing both experimental and theoretical determinations at any level of uncertainty in any field of science and technology."[1]

Metrology and Trade

Globally there is an increased understanding of the importance of metrology to the economy and to society as a whole. Accurate measurement forms the backbone of technical regulations, documentary standards and legal metrology, thus it is the prerequisite for free and fair trade nationally and internationally. In every institute, company, or organization, concepts such as safety, security, efficiency, reliability, and precision are of paramount importance in designing systems, which provide guarantees of product quality. Accurate and widely accepted measurements are important in ensuring that market transactions can take place and that consumers can feel confident that the goods they buy are of the quantity and quality they except. Importantly for developing countries, accurate and internationally accepted measurements allow market access for food and commodity exports. Accurate and precise measurements curb the buyer's tendency to want more and the seller's tendency to give less.

REMINDERS FROM A METROLOGIST

- What cannot be measured cannot be manufactured.
- What cannot be measured cannot be tested.
- What cannot be measured cannot be certified.

[1] Bureau International des Poids et Mesures (2021). BIPM. Retrieved from https://www.bipm.org/en/home

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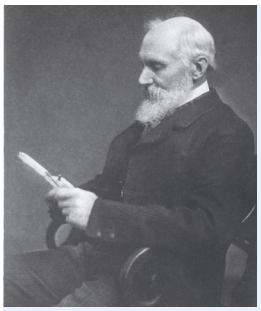


"I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the state of Science, whatever the matter may be."

–William Thomson, Lord Kelvin, 1824 – 1907

Metrology in Our Daily Life

A study of history shows that the economic progress and growth of a nation is directly related to their progress in implementing and maintaining a unified national measurement system. Many decisions in life are based on measurements. Measurements influence and are an integral part of our daily lives, a fact that we often forget.

Almost everything we buy is purchased by weight, length, volume, or measure: a kilogram of meat, a liter of gas, a meter of clothing.

In a conversation, one might ask:

- What is the temperature today?
- What time is it?
- How tall are you?
- How much does it weigh?
- How fast is my automobile traveling?

All of these assume an accurate unit of measurement.

A BRIEF HISTORY OF METROLOGY

The concept of measurement long pre-dates the establishment of formal bodies such as national metrology institutes (NMIs) or other designated institutes. The creation of internationally agreed upon measurement units, standards, and methodology have contributed to the recognition of measurement standards across these bodies.

Photo: Ed Nemeroff

The Royal Egyptian Cubit

One of the earliest records of precise measurement comes from Ancient Egypt.[2] The Egyptians studied the science of geometry to assist them in the construction of the great pyramids and temples. The Egyptian unit of length came into being about 3000 years BC. The "Royal Egyptian Cubit" was defined as equal to the length of the forearm from the bent elbow to the tip of the extended middle finger, plus the width of the palm of the hand of the Pharaoh ruling at that time.[3]

The "Royal Cubit Master"[4] was a rod carved out of a block of black granite.[5] Workers engaged in building tombs, temples, pyramids, and other buildings used cubits made of wood or granite. The Royal Architect or Foreman of the construction site was responsible for maintaining and transferring the unit of length to workers' instruments. They were required to bring back their cubit sticks at each full moon to be compared to the Royal Cubit Master, and

[2] Bruel & Kjaer (2021). The Birth of Calibration. Retrieved from https://www.bksv.com/en/knowledge/blog/perspectives/egyptian-cubit
[3] Bruel & Kjaer (2021). The Birth of Calibration. Retrieved from https://www.bksv.com/en/knowledge/blog/perspectives/egyptian-cubit
[4] The Story of the Egyptian cubit and the Papyrus as presented to Ed Nemeroff by Professor, Dr. Mohamed El-Fiki, President of the Egyptian National Institute for Standards during the US - Egypt Bilateral Workshop on Metrology, Standards & Conformity Assessment, Alexandria Egypt. June 9-13, 1996.
[5] Bruel & Kjaer (2021). The Birth of Calibration. Retrieved from https://www.bksv.com/en/knowledge/blog/perspectives/egyptian-cubit

failure to comply was punishable by death.[6] Thanks to this standardization and uniformity of length, the Egyptians achieved tremendous accuracy. The Egyptian commitment to accuracy was essential in building the Great Pyramid of Giza. With the use of cubit sticks, the thousands of workers enlisted to build the Pyramid achieved an accuracy of 0.05%. Sides of the pyramid measured roughly 756 feet or 9,069.4 inches, and were within 4.5 inches of the desired result.[7]

Beyond the cubit, Egyptians set precedents for modern measurements of weight, time, and the monetary system. They used scales to weigh precious metals and gems and later initiated the modern monetary system by stamping gold and silver coins with their weight. This practice spread throughout the Mediterranean region. Additionally, our conception of time is based on the sexagesimal system (based on the number 60) developed near Egypt, in Mesopotamia, and our calendar is derived from the original 365-day Egyptian calendar. The contributions of the Egyptians to the current system of metrology are clear to this day.

The Importance of Mutual Recognition of Measurements

Mutual recognition of measurements plays an important role in reducing technical barriers to trade, and thus facilitating global trade.

International measurement systems are built on consensus, established by the world's National Metrology Institutes (NMI). These bodies base measurement and measurement uncertainties on the International Systems of Units (SI). Adopted in 1960, the SI consists of seven independent base units: meter (length), kilogram (weight), second (time), ampere (electric current), kelvin (thermodynamic temperature), mole (amount of substance), and candela (luminous intensity). These base units are combined to create derived units defining new quantities, such as the volt, watt, newton, pascal, and joule.[8]

Comparing national measurement, through an NMI, is essential in establishing mutual equivalence among measurements and enhances measurement capabilities while strengthening international trade through the reduction of technical barriers to trade (TBT). Thus, the capacity of NMIs to concretize this mutual equivalence of national measurement standards and calibration capacity becomes a key factor in a nation's ability to engage in global trade. Such equivalence is determined through bilateral agreements, as well as regional multilateral agreements organizations. In 1999, the Comité International des Poids et Mesures (CIPM – International Committee for Weights and Measures) and the BIPM jointly established the Mutual Recognition Arrangement (MRA) program to serve as a tool within wider trade and commercial agreements among nations.[9]

The creation of internationally agreed upon measurement units, standards, and methodology have contributed to the recognition of measurement standards across these bodies.

The Earliest Unit of Mass (Weight)

The earliest unit of mass (weight) recorded is the grain. While the magnitude of each measurement differed from civilization to civilization, these systems all served the greater purpose of facilitating trade. Commercial

Seed, grains, and stones were used as weights – the earliest units of mass.

[6] Bruel & Kjaer (2021). The Birth of Calibration. Retrieved from https://www.bksv.com/en/knowledge/blog/perspectives/egyptian-cubit
[7] NSCL International (2021). What is Metrology. Retrieved from https://ncsli.org/page/WIM
[8] BIPM (2021). The International System of Units (SI). Retrieved from https://www.bipm.org/en/measurement-units
[9] Bureau International des Poids et Mesures (2021). CIPM Mutual Recognition Arrangement (CIPM MRA). Retrieved from https://www.bipm.org/en/measurement-units

goods were originally traded by number or volume, but this was slowly replaced by the weighing of goods. In these early systems of measurement, mass was based on a volume of grain or water. It is likely that the overlap among units with same or similar name across different regions and languages arises from these early trade relationships.

1875 – Meter Convention – The Creation of BIPM

In May 1875, the "Convention of the Meter" treaty (Convention du Mètre) spurred the establishment of the International Bureau of Weights and Measures (BIPM). The BIPM is an intergovernmental organization that falls under the authority of the General Conference on Weights and Measures (CGPM), and under the supervision of the CIPM. Today, there are 63 Member States of the Meter Convention, and 39 Associate States and Economies of the General Conference.[10] The convention served to lay a foundation for the creation, financing, and management of the BIPM, and further as a convening body and organizational structure for member governments to coordinate action on matters relating to units of measurement.

The BIPM is a pivotal actor in world metrology, and provides important guidance in providing measurement standards that are increasingly accurate, wide-ranging, and diverse. This is of specific interest in the domain of national measurement standards, where demonstrating equivalence is all the more important for actors.[11]

1960 – International System of Units (SI)

The Système International d'Unités (SI) was adopted in 1960 as the recommended practical system of units of measurement. The SI is a system of units founded on older metric systems and adopted by the CGPM, the highest international authority on units.

As stated above, the SI consists of seven independent base units, and these base units can be combined to create derived units defining new quantities. In sum, the base and derived units form the coherent SI units. Ultimately, the SI is not static. Rather, it evolves to accommodate the world's increasingly demanding requirements for specific measurement.

The Seven Base Units of the SI[12]

Base Quantity		Base Unit	
NAME	**TYPICAL SYMBOL**	**NAME**	**SYMBOL**
time	*T*	second	s
length	*l*, *x*, *r*, etc.	metre	m
mass	*M*	kilogram	kg
electric current	*I*, *i*	ampere	A
thermodynamic temperature	*T*	kelvin	K
amount of substance	*N*	mole	mol
luminous intensity	I_v	candela	cd
All other SI units can be derived from these, by multiplying together different powers of the base units.			

[10] NIST (2021). The NIST Reference on Constants, Units, and Uncertainty. Retrieved from https://physics.nist.gov/cuu/Units/international.html
[11] Bureau International des Poids et Mesures (2021). The Metre Convention. Retrieved from https://www.bipm.org/en/metre-convention
[12] BIPM. The International System of Units (SI): Base units. Retrieved from https://www.bipm.org/en/measurement-units/si-base-units

BIPM Revision of the International System of Units (SI)

In the 2018 revision of the SI, the definitions of four of the SI base units – the kilogram, the ampere, the kelvin and the mole – were changed. Their new definitions are based on fixed numerical values of the Planck constant (h), the elementary charge (e), the Boltzmann constant (k), and the Avogadro constant (N_A), respectively. Further, the definitions of all seven base units of the SI are now uniformly expressed using the explicit-constant formulation. Specific mises en pratique (practices) have been drawn up to explain the realization of the definitions of each of the base units in a practical way.

This revision ensures flexible usage and stability of the SI as new technologies, such as quantum technologies, continue to impact our understanding of measurement and the natural world.[13]

CATEGORIES OF METROLOGY

Depending on the field of application, metrology can be sub-divided into three categories:

- Scientific Metrology
- Legal Metrology
- Industrial Metrology

Scientific Metrology

Scientific Metrology is the foundation of all the subfields of metrology. It involves "the establishment of and maintenance of measurement units, unit systems, development of new measurement methods, realization of measurement standards (study, organization, maintenance, and development of standards for metrology) and the transfer of traceability from these standards to users in society."[14] In general, scientific metrology is developed by NMIs and internationally coordinated by BIPM.[15]

Scientific metrology covers three main tasks:

- Definitions for internationally accepted units of measurement
- Establishment and dissemination of units of measurement by scientific methods
- Establishment of traceability chains in documenting the accuracy of a measurement[16]

Legal Metrology

Legal metrology is the legislative, administrative and technical procedures established by, or by reference to public authorities, and implemented on their behalf in order to specify and to insure in a regulatory of contractual man, the appropriate quality and credibility of measurements related to official controls, trade, health, safety and the environment.[17]

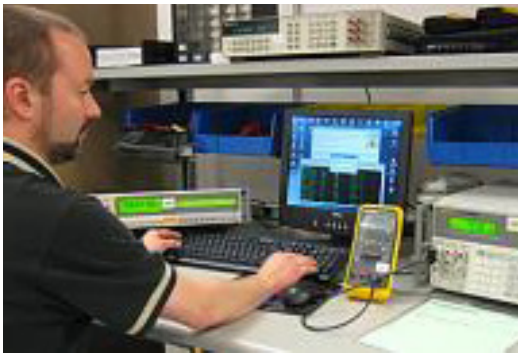
In short, legal metrology is the practice and the process of applying regulatory structure and enforcement to metrology. A credible measurement system is vital for trade in any society. All measurements related to trade and consumer protection come under the forum of legal metrology, specifically in the area of weights and measures.

Metrology is at the core of all commercial transactions, with most of these based on some sort of unit of measurement (weight, volume, length, count). Whether it is pre-packaged goods at the grocery store, produce items priced based on weight, car fuel purchased based on volume, or grain prices being adjusted based upon measurements of quality – all of these fall under legal metrology.[18]

Trade and economic development are

[13] Bureau International des Poids et Mesures (2018). 26th meeting of the CGPM. https://www.bipm.org/en/committees/cg/cgpm/26-2018
[14] Standards and Metrology Institute for Islamic Countries/Metrology Council (2021). Scientific Metrology. https://mc.smiic.org/en/scientific-fundamental-metrology
[15] Standards and Metrology Institute for Islamic Countries/Metrology Council (2021). Scientific Metrology. https://mc.smiic.org/en/scientific-fundamental-metrology
[16] Euramet (2008). Metrology https://www.euramet.org/
[17] International Organization of Legal Metrology (OIML) (2021). What is legal metrology? https://www.oiml.org/en/about/legal-metrology
[18] NIST (2011). Weights and Measures Program Requirements: A Handbook for the Weights and Measures Administrator. https://www.nist.gov/system/files/documents/2017/04/28/hb-155-final.pdf

Industrial metrology is an important indicator of a country's economic and industrial development.



Industrial Metrology

The function of industrial metrology is the application of measurements and proper calibration and control of measuring equipment in a manufacturing process. It is carried out against certified equipment, with a known valid relation to standards such as, a national reference standard. The purpose is to ensure that the products produced comply with required standards.

fundamental human activities, and operate on the principle of fair exchange of products between two parties, which may be persons or organizations.

Legal metrology ensures that all measurements made for the purpose of exchanging products as part of trade are fair and credible. For instance, the idea of "getting what you pay for" when you purchase a kilogram of meat, a liter of gas, or a meter of cloth is a reflection of legal metrology. Those measuring devices, which themselves are legally controlled, such as gas pump meters, taxi meters, household electricity meters, and scales in the marketplace, are all a major part of legal metrology. In addition, devices, which may be used for law enforcement (such as breath analyzers), in medical applications (such as blood pressure monitors or clinical thermometers), or in other fields, also fall under the category of legal metrology.

THE ROLE OF A NATIONAL METROLOGY INSTITUTE (NMI)

An NMI is an organization designated by governmental decision to develop, maintain, and disseminate the national measurement system based on the SI. It represents the country internationally in relation to the NMIs of other countries, as well as in relation to the Regional Metrology Organizations (RMO) and to the BIPM. NMIs are the backbone of the international metrology system.

Some countries operate a centralized metrology organization with one NMI. In others, the NMI may outsource the maintenance of specific standards to other government agencies or a competent in-country laboratory without these having the status of a NMI. A third structure that some countries use is a decentralized organization

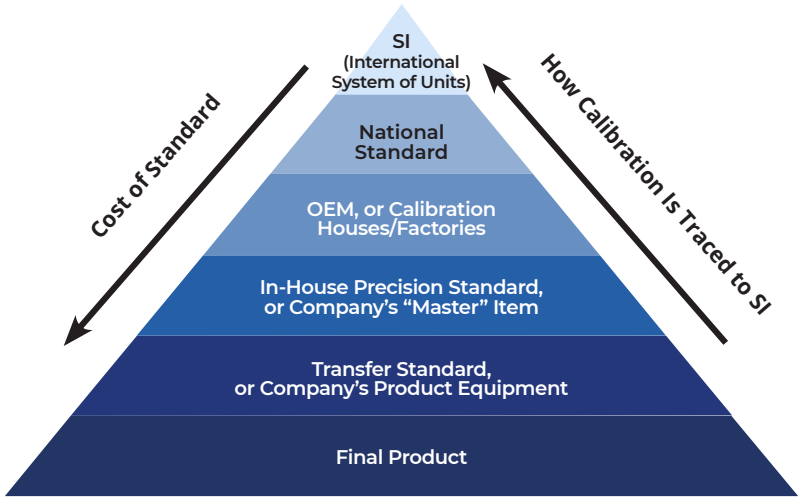
Examples of National Metrology Institutes

NIST, United States

INNOQ, Mozambique

NIMM, Myanmar

Measurement Traceability



with a multiplicity of institutes, all having the status of a NMI. NMIs oversee the traceability of measurement, calibration, and measurement standards activities of a county.

Traceability of Measurement

Traceability ensures that a measurement result or the value of the standard is related to references through an unbroken chain of comparisons. A calibration laboratory "establishes traceability of its own measurement standards and instruments to the SI by means of an unbroken chain of calibrations or comparisons linking them to relevant primary standards of the SI units of measurement."[19]

Linking calibration to SI units is done through national measurement standards, which may be primary standards. SI units are primary standards when tethered to fundamental physical constants. All test equipment requiring calibration should undergo an initial calibration before being put into service.

Calibration

Calibration refers to the verification of instruments to ensure the precision and traceability of a measurement. Calibration involves determining the metrological characteristics of an instrument. This is achieved by a direct comparison to a higher accuracy know standard. A calibration certificate or test report is issued. Based on this information, a user can decide whether the instrument is fit for the application.

MEASUREMENT STANDARDS

A measurement standard (etalon/artifact) is a material measure, measuring instrument, reference material, or measuring system intended to define, realize, conserve, or reproduce a unit or one or more values of a quantity to serve as a reference. NMI's are responsible for overseeing legislation relating to measurement and its application in everyday commerce.

Types of Measurement Standards

Within the field of metrology, experts rely on three main types of measurement standards. These include primary measurement standards, secondary measurement standards, and working measurement standards.

A primary measurement standard is based on physical constants. These are widely acknowledged as having the highest metrological quantities, and their value is accepted without reference to other standards of the same quantity.

A secondary measurement standard is valued in comparison with a primary standard of the same quantity. That is, they are calibrated upon the primary standard.

A working measurement standard is used routinely for the calibration of equipment and measuring instruments in general use, having less accuracy than secondary measurement standards.

[19] ISO Budgets blog (2016). Measurement Traceability: Complying with ISO 17025 Requirements. Retrieved from https://www.isobudgets.com/measurement-traceability-complying-iso-17025-requirements/

INTERNATIONAL METROLOGY ORGANIZATIONS

Bureau International des Poids et Mesures (BIPM) www.bipm.org

The BIPM is an intergovernmental organization through which Member States act together on matters related to measurement science and measurement standards. The goal of the BIPM is to ensure worldwide uniformity of measurements and their traceability to the International System of Units (SI). It does this with the authority of the Convention of the Metre, a diplomatic treaty between 51 nations, and it operates through a series of committees whose members are the National Metrology Institutes of the Member States of the Convention.

The unique role of the BIPM is based on its international and impartial character enabling it:

- To coordinate the realization and improvement of the worldwide measurement system to ensure it delivers accurate and comparable measurement results.
- To undertake selected scientific and technical activities that are more efficiently carried out in its own laboratories on behalf of Member States.
- To promote the importance of metrology to science, industry, and society, in particular through collaboration with other intergovernmental organizations and international bodies and in international forums.[20]

International Organization of Legal Metrology (OIML) www.oiml.org

An intergovernmental treaty organization whose membership includes Member States and Corresponding Members (observer countries), the OIML was established in 1955 to promote global harmonization of legal metrology procedures.[21]

REGIONAL METROLOGY ORGANIZATIONS

Intra-Africa Metrology System (AFRIMETS) http://www.afrimets.org/SitePages/Home.aspx

To harmonize metrology activities in Africa, AFRIMETS was established, based on the Regional Metrology Organization (RMO) of the Americas, SIM (Inter-American Metrology System). An assembly meeting was held in July 2007 at the premises of the New Partnership for Africa's Developmen (NEPAD), and an MOU was finalized and signed by five sub-regional metrology organizations (SRMOs) – SADCMET, EAMET, CAMET (later changed to CEMACMET), SOAMET, and MAGMET – representing 42 countries in Southern, Eastern, Central, Western, and North Western Africa. In addition, three countries have signed on as individual (Ordinary) members, and multiple other metrology organizations participate as Associate or Observer members.[22]

Inter-American Metrology System (SIM) https://sim-metrologia.org/

SIM is the regional organization for metrology in the Western Hemisphere, and consists of the National Metrology Institutes from 34 member nations represented at the Organization of American States, which acts as its Executive Secretariat. SIM coordinates its functions based on an organization of five sub-regions that corresponds to the five main economic and commercial groups in the region. These metrology groups are NORAMET (North America), CAMET (Central America),

[20] Retrieved from https://www.bipm.org/en/home
[21] Retrieved from https://www.oiml.org/en/
[22] Retrieved from http://www.afrimets.org/SitePages/Home.aspx

CARIMET (the Caribbean), ANDIMET (Andean Group), and SURAMET (South America).[23]

Euro-Asian Cooperation of National Metrological Institutions (COOMET) www.coomet.org

COOMET is the regional organization originally establishing cooperation of state metrology institutes of countries of Central and Eastern Europe. It was founded in June 1991, and renamed in "Euro-Asian Cooperation of State Metrology Institutions" in May 2000. COOMET is open for any metrology institution from another region to join as an associate member. The current members of COOMET are the metrology institutions from Belarus, Bulgaria, Georgia, Germany (associate member), Kazakhstan, Kyrgyzstan, DPR of Korea (associate member), Cuba (associate member), Lithuania, Moldova, Russia, Romania, Slovakia, Uzbekistan, and Ukraine.[24]

European Cooperation in Legal Metrology (WELMEC) www.welmec.org/

When WELMEC was founded in June 1990, the acronym stood for "Western European Legal Metrology Cooperation." However, today WELMEC extends beyond Western Europe and includes representatives from Central and Eastern Europe. The principal aim of WELMEC is to establish a harmonized and consistent approach to European legal metrology.[25]

European Association of National Metrology Institutes (EURAMET) www.euramet.org

EURAMET is the Regional Metrology Organization for Europe. European metrology was coordinated successfully over almost 20 years by EURAMET as a collaboration based on a Memorandum of Understanding (MOU); but the new challenges facing European metrology, and in particular the higher level of integration necessary to manage the multi-million-euro European Metrology Research Program (EMRP), required a legal entity that could enter into contractual obligations on behalf of its Members, the European National Metrology Institutes (NMIs). As well as running the EMRP, EURAMET continues to coordinate the cooperation between the European NMIs in support of the CIPM Mutual Recognition Arrangement (MRA). It organizes regional inter-comparisons between European NMIs and validates their calibration and measurement capabilities.[26]

Asia Pacific Metrology Program (APMP) http://www.apmpweb.org

APMP is primarily responsible for developing international recognition of the measurement capabilities of the region's national and territorial measurement laboratories. APMP has been operating in the Asia-Pacific since its inception as a Commonwealth Science Council initiative in 1977. As such, it is the oldest continually operating metrological grouping in the world.[27]

Asia-Pacific Legal Metrology Forum (APLMF) www.aplmf.org

APLMF is a grouping of legal metrology authorities in the Asia-Pacific Economic Cooperation (APEC) and other economies on the Pacific Rim. The objective is the development of legal metrology and the promotion of free and open trade in the region through the harmonization and removal of technical or administrative barriers to trade in the field of legal metrology. APLMF was established in November 1994 with 14 member economies but now includes 21 Full Members and 7 Corresponding Members.[28]

[23] Retrieved from https://sim-metrologia.org/
[24] Retrieved from http://coomet.org/
[25] Retrieved from https://www.welmec.org/
[26] Retrieved from https://www.euramet.org/
[27] Retrieved from http://www.apmpweb.org/
[28] Retrieved from https://www.aplmf.org/

METROLOGY REFERENCES

NCSL International (NCSLI) http://www.ncsli.org
NCSLI is the world's premier technical organization dedicated to the field of metrology, and conformity assessment. It was formed in 1961 to promote cooperative efforts for solving the common problems faced by measurement laboratories. Today, NCSL International has over 1,200 member organizations from academic, scientific, industrial, and commercial and government facilities around the world. The mission of NCSL International is to advance technical and managerial excellence in metrology, measurement standards, conformity assessment, instrument calibration, and test and measurement through voluntary activities aimed at improving product and service quality, productivity, and the competitiveness its members in the international marketplace.

Measure https://ncsli.org/page/mj
NCSL International's publication includes sections on Learning and Development, an Educator's Corner, Education Outreach, Scholarship Promotion, Lab Tours, Accreditation, and Publication Reviews and Summaries.

SIM Metrologia: Measurement Uncertainty
https://sim-metrologia.org/wp-content/uploads/2020/10/PossoloMeija2020-MeasurementUncertainty.pdf
A brief summary of the method of evaluating and for expressing uncertainty in measurement.

The International System of Units (BIPM) https://www.bipm.org/en/publications/si-brochure
A reference guide for the proper use of the SI system.

Metrologia www.bipm.org
An international journal published by BIPM dealing with scientific aspects of metrology.

A2LA/WorkPlace Training (computer-based, interactive metrology training)
http://www.A2LAWPT.org
Workplace Training offers a series of computer based interactive training courses. Their goal is to improve measurement quality by increasing the calibration knowledge infrastructure in developing countries. All of the following courses come with complete testing and documentation in the form of a Certificate of Competency.

CALAB – The International Journal of Metrology
www.callabmag.com
This quarterly published magazine is a resource of current metrology information that contains technical articles, calendar of metrology events, industry and research news, and new products and services.

International Vocabulary of Metrology – Basic and General Concepts and Associated Terms
https://www.bipm.org/en/committees/jc/jcgm/publications
This document is a terminological dictionary containing designations and definitions from the field of metrology. It covers the basic principles governing quantities and units.

The International Vocabulary of Terms in Legal Metrology (VIML) viml.oiml.info
A set of terms and definitions published by OIML, intended for use by metrologists and other specialists involved in various activities related to legal metrology, from measurement and legal metrological control to legislation.

CONTINUE READING HANDBOOK ▸
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