

Introduction to Metrology Services

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Abstract: The movement towards systems, which ensure quality of services provided and products manufactured by companies, is now a worldwide one. Today is taken for granted that a measurement represents the same quantity everywhere. But it has not always been that way; this is a result of an international metrology system. This paper describes the basic principals of metrology services and the infrastructure required to demonstrate traceability of measurements to the Systéme International d'Unités (SI).

1 Introduction

The effects of the science of measurements can be seen everywhere, allowing people to plan their lives and make commercial exchanges with confidence. For example, most people can assume that the clocks in their homes and the clocks in their work places all display approximately the same time. Similarly, a kilogram of sugar purchased from one store will contain the same quantity of food as the same amount purchased at the store across town. Most people also trust that the speedometers in their cars will measure speed the same as the local police's; and the temperatures indicated by thermostats, ovens, and thermometers are correct. Life would get complicated and in

some cases, more dangerous, without proper measurements.

1.1 Metrology

Simply stated, metrology is the science of measurement. Everything that has to do with measurement, be it designing, conducting or analyzing the results of a test, exists within the metrology realm.

1.2 The Romance of Metrology

Greek science opened the door to a rational view of nature. By Aristotle's time, nature's behaviour could be relied on to be rational, consistent and understandable.

In the modern continuation, we metrologists trust the laws of nature to be the

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same at all times for all observers. We seek to derive our standards of weights and measures from the vary structure of nature itself! When we do this, nature cannot give us a "false measure", or so we believe.

What is the structure of nature? How do we define it? These are deep questions that Many Greek Scientists addressed years back. The Pythagoreans thought that nature is mathematical in its ultimate expression. Plato advanced the concept that it has an underlying perfection in form, if not representation. It is said that the first experimentalist was Archimedes, who according to legend, ran naked through the streets of Syracuse shouting "Eureka! Eureka!" in reaction to his discovery of the physical relationships between buoyancy and volume. But it was by experiment that he confirmed this law and his equally important law of the lever. And so it is today, every measurement we make is an experiment that tests the fitness of correspondence between the actual performance of an apparatus and its principles of operation.

2 Metrology in Practice

2.1 Calibration

Calibration is the process of comparing a measurement device (an unknown) against an equal or better standard. A standard in a measurement is considered the reference; it is the one the comparison taken to be the more correct of the two. One calibrates to find out how far the unknown is from the standard.

The International System of Units (SI) provides a set of standard measurement units, by which all measurements are made or referenced. There are seven basic measurement units from which all other measurement units are derived. The seven basic units are metre (length), second (time), mole (amount of substance), candela (light intensity), ampere (current), Kelvin

(thermodynamic temperature) and kilogram (mass).

2.2 Traceability

The process of making a measurement is only a part of calibration. During the measurement, all of the data concerning the unit's response is recorded either manually or automatically. The information in the test record supports the traceability of the test. Traceability is an unbroken chain of comparisons from the measurement being made to a recognized national legal standard. If one were to follow the paper trail up from the calibrated unit through the secondary and primary standards, it would eventually end at the record of an experiment made to establish the quantity in question in terms of one or more of the seven basic measurement units (see **Figure 1**)

2.2.1 International System

In the traceability diagram (**Figure 1**) the International System (SI) (which is the basis of all modern measurements) is a coherent system of units adopted and used by international agreements. This international use of the SI depends on scientific cooperation and legal agreements. Scientific cooperation is focused on improving the definition, realisation, representation and dissemination

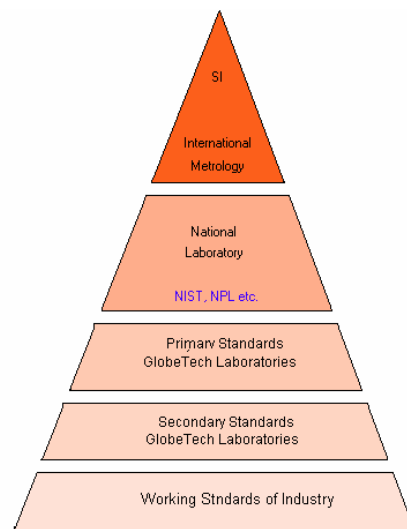


Figure 1. Traceability Diagram

of the basic units of measurement. On the other hand the legal agreements ensure that scientific progress can be readily transferred across international borders to provide global support for advances in metrology and commerce.

2.2.2 National Laboratories

The SI is a set of definitions. National laboratories have participated in defining the SI units and in conducting experiments to realize (express) the units as define.

Each nation has set up its own National Measurement Systems (NMS), consisting of a national laboratory at the top of the hierarchy and a number of facilities of varying capability at lower levels in the hierarchy. National laboratories establish, maintain and disseminate the primary (physical) standards for the country. Calibration and measurement services are provided by the lower level laboratories.

2.2.3 Primary and Secondary Standards

Reference (primary and secondary) standards that have traceability to National Laboratories are maintained at GlobeTech Calibration Laboratories. The trained personnel using well documented procedures and appropriate standards can calibrate and transfer the traceability to working standards.

2.2.4 Working Standards of Industry

Laboratories which have the appropriate equipments and trained personnel to calibrate process equipment, instruments and machinery. Calibration of the industrial and commercial equipment, instruments and machinery is vital to demonstrate consistent quality and it is mandatory for ISO9000 certified companies.

2.3 Regulations

One of the reasons that traceability forms an unbroken chain is that the commercial and legal aspects of metrology are regulated. All governments have regulations/laws that cover the practice of checking all commercial/industrial measurements.

3 Metrology Services

3.1 National Metrology Structure

The presence of a National Measurement System (NMS) is vital for the cooperation of all commercial centers and the upgrading of quality for global competitiveness of the industry. This NMS framework requires the existence of a National Institute of Metrology, Accreditation Body, Notification Agency, Independent Calibration Laboratories and Legislation. These are some of the vital organizations that the NMS framework should consist off.

3.1.1 National Measurement System (NMS)

NMS is a framework under which the different entities are present, such as: National Institute of Metrology, Accreditation Body, Independent Calibration Laboratories and Legislation.

3.1.2 National Institute of Metrology

The National Institute of Metrology (or National Laboratory) is a government institution, which maintains representations of the units (physical standards), to which calibrations in their respective countries are legally traceable. This institution offers its services to the independent laboratories by ensuring consistency and traceability of measurements throughout the nation.

3.1.3 Accreditation Body

The accreditation body is an independent organization, which provides accreditation to independent laboratories.

3.1.4 Independent Calibration Laboratories

Independent calibration laboratories have the appropriate equipments where the industry can calibrate their instruments and machineries.

3.1.5 Legislation

Legislation is required to ensure an unbroken chain for traceability and cover the practice of checking all commercial/industrial measurements.

4 Concluding Remarks

Metrology services are necessary in order to support industry provide the required quality. Metrology has a global structure with the higher point of reference the International System of Units (SI). National laboratories not only participated in defining the SI but also establish, maintained and disseminate the primary standards for the country.

Calibration and measurement services to the commerce and industry are provided by GlobeTech Laboratories.

GlobeTech Laboratories believes that the calibration laboratory will form the link between the Cyprus Industry and the National Institute of Metrology. It is the target that the professional services that are offered will result to the upgrading of the quality and eventually competitiveness of the Cyprus products in the global market.

5 References

1. Alan S. Moris, "*Measurement and Calibration Requirements for Quality Assurance to ISO 9000*", John Wiley & Sons, **1997**
2. GlobeTech Laboratories, "*Notes on Applied Calibration*", Technical Report, **2001**
3. EU, "*European Union Progress Report*", **October 1999**
4. Fluke, "*Calibration: Philosophy in Practice*", **Second Edition, 1994**
5. NIST, "*Guide for the Use of the International System of Units, The Modernized Metric System*", **NIST Special Publication, 811**

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He then joined Imperial College of Science, Technology and Medicine of the University of London as a Graduate Scholar, sponsored by the Engineering & Physical Science Research Council, where he obtained the DIC and PhD in Chemical Engineering.

For the last ten years Marios, has been involved with the field of Metrology, Calibration and Testing. He played a major part in the development of the commercial Calibration - Metrology field in Cyprus and the Kingdom of Bahrain.

He is Currently the Chairman of GlobeTech Group and Managing Director of GlobeTech Laboratories Ltd, GlobeTech Engineering & Trading Ltd, Calibration & Testing GlobeTech Laboratories A.E and Universal Laboratories (Bahrain) WLL that specialises in offering Calibrations and Testing services to the Industry.