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MEASURES TO BE TAKEN FOR A WORLDWIDE RECOGNITION OF CERTIFICATES IN METROLOGY

M. Kochsiek and A. Odin
Physikalisch-Technische Bundesanstalt, Braunschweig und Berlin
Bundesallee 100, D-38116 Braunschweig, Germany

Abstract: In most of the industrialized countries manufacturers of measuring instruments and bodies rendering services for tests and calibrations have to have calibrations and tests repeated at present. With more than 230 countries recognized by the UNO and about 100 countries active on the world market, this is a considerable cost factor for the supplier, and a waste of resources for the national economies. Starting off on the basis of the status quo in fundamental, industrial and legal metrology and the relevant institutions, the necessary measures to be taken to achieve world wide recognition of type approvals and/or certificates will be described. One essential step took place in the field of fundamental metrology on 14 October 1999 in Paris by the signing of a Mutual Recognition Arrangement (MRA) of the Meter Convention for calibration and measurement certificates issued by national metrology institutes. ILAC is about to elaborate a concept for the recognition of certificates in the field of industrial metrology, and so is OIML in the field of legal metrology.

Keywords: trade barriers, global measurement system, mutual recognition arrangement, world wide recognition, certificate, quality system

1 INTRODUCTION

No other period of this century has brought about so many changes in the field of technical and economical development of a country as the last 20 years have done. Metrology, the art and science of measurement, is as old as mankind and its development is closely linked to the development of living standard, culture, science, technology and trade. Hints of the existence of uniform length standards date back as far as the fifth millennium B.C. We know that the great cultures and empires such as China, Egypt, ancient Greece, and the Roman Empire had a highly developed system of standards for weights and measures. Impressive examples are length standards of the ancient China realized by the length of a bamboo flute where the tone of the flute could be used for comparisons, or the famous Nippur cubit found in the temple of Nippur in ancient Mesopotamia.

This high culture in metrology, however, got lost as feudalism came up and, actually, about 300 years ago we had in Germany as many as 50 different pounds and more than 30 different foot as standards of mass and length, respectively. Yet, about 200 years ago a development began to overcome the unfortunate consequences of the “Tower of Babel”. At the beginning it were the scientists who requested a uniform and robust system of units and standards.

Apart from science, where a uniform system of units and standards was urgently needed for a quantitative description of the laws of nature, the upcoming industrialization and trade across borders were pushing into the same direction. However, it took almost another century until the metric system was introduced. The establishment of the Meter Convention in 1875 clearly was the successful end to these efforts and at the same time the starting point for a new era guided by the vision of a world without borders, at least in metrology, science in general, and trade. One of the most important milestones in this sense was the adoption and introduction of the Système International d’Unités (SI) by the 10th General Conference (CGPM) of the Meter Convention in 1960.

2 BARRIERS TO TRADE

There are in fact a large number of barriers to trade which obstruct free trading in the world. Metrology can only influence the technical side, i.e by requiring physical units, product specifications, conformity assessment and test certificates.

Some years ago the World Trade Organisation (WTO) has ascertained the role of metrology. In particular it found out that there were differing standards and technical regulations as well as costly conformity assessment requirements in many countries. The Technical Barriers to Trade (TBT) Agreement (1995, 46 signatories) was negotiated with a view to minimise that kind of technical barriers to trade.

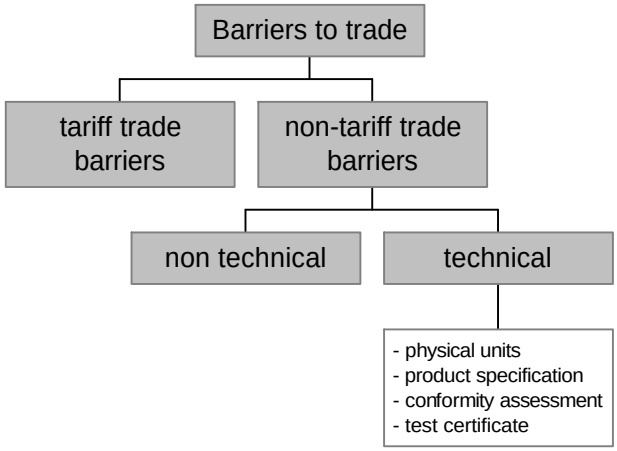

Figure 1. Barriers to trade

To provide secure and predictable trading environment and to liberalise trade the following ensues:

- Non discrimination
- Avoidance of unnecessary obstacles to trade (like languages, trade restriction)
- Harmonisation of technical regulations, standards and conformity assessment procedures
- Principle of equivalence
- Mutual recognition of conformity assessment
- Transparency

There are two areas where metrologists have to act immediately (Fig. 2).

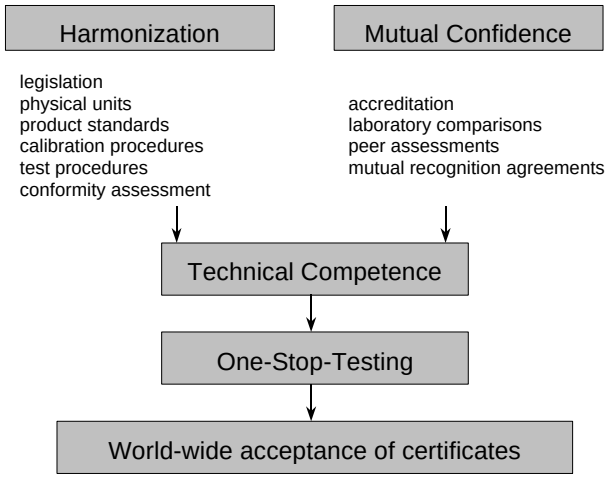

Figure 2. Removal of metrological barriers to trade

In the first place they have to try to achieve **harmonisation of legislation**, of the physical units, of products standards, of calibration and test procedures as well as of conformity assessment. Secondly, mutual confidence has to be built up which should be done by accreditation, interlaboratory comparisons, peer assessment, self declaration of the National Metrology Institutes (NMI), and by mutual recognition agreements.

3 PRESENT SITUATION IN METROLOGY

For both areas (harmonisation and building up of mutual confidence) it is essential to establish and maintain a staff which is technically competent and also to have the required technical equipment.

The progress made in the metrological field so far is varying considerably from country to country. Whereas the metric units of measurement (1875) which were introduced by the SI-system in 1960 and were implemented by all the countries except for the USA, the other harmonisation activities and the establishment of a mutual confidence system proceed very slowly.

Therefore the stipulation of world wide technical equivalence of the metrological services was getting stronger and stronger at the end of the last millennium. Long-known problems, which metrologists have to face to be able to cope with upcoming changes, were addressed and frankly discussed all over the world and by the most varying circles of interest. The main items of interest are

- Agreements on the definition and realisation of the units of measurement
- Proof of international equivalence of the standards
- Organisation of intercomparisons; publication of the results and conclusions
- Multilateral co-operation in regional and international areas.

The problems were taken up by international organisations like BIPM, OIML, ISO, IEC, IAF and ILAC. Never before the objectives which metrologists and their clients had set themselves were clearer, i.e. establishment of a global measurement system realising the principle: “Once measured – world wide recognized”.

The decisive impact in this was given by the rapidly increasing globalisation of trade and economy which exerted intense pressure on all the parties involved. Global markets require global activities – this applies to metrology as well. It is by global activities only that the prerequisites for the elimination of barriers to trade may be established.

Keeping this in mind, it is all the more amazing that even 125 years after the signing of the Meter Convention the world wide implementation of fundamentals for a harmonisation has still to be discussed. In this connection it has to be said that in the USA, for example, not only the units of measurement deviate from the standards which are applied almost everywhere in the world, but that subdivision of the units in many cases is not carried out according to the decimal system applied in most of the industrialised countries.

The problems that may arise whenever harmonisation is carried out half-heartedly became obvious by the failure of the mars mission in September 1999. Instead of being put into stabile orbit, the satellite burnt out in the atmosphere of mars. Reason for the failure: The control centres in Denver and Pasadena had used differing units of measurement, i.e. the one team had used meters and kilograms, the other had used feet and pounds [2]. Apparently, the efforts of the American metrologists and of the US Government to introduce the metric system are a tough wrestling against old habits.

However, even in the classical realisation and dissemination of the SI units there is still a lot left to be done. The metrological traceability to SI units has played a fundamental role – not only since quality systems have been introduced world wide in industrial practice. The metrological traceability to national standards required by all the quality systems assumes their equivalence of course, which consequently should results in an unbureaucratical mutual recognition of test reports issued by the national metrology institutes (NMI). Numerous metrology institutes and international organisations are therefore dealing with the elaboration of criteria for a mutual recognition of test reports.

The problem is not a new one for the NMI. Ever since their foundation the ensuring of international comparability has been one of their main tasks and part of their traditional identity. For that reason the NMI reacted most rapidly to these developments by setting up a fundamental agreement under the umbrella of the Meter Convention, i.e. in the autumn of 1999 the heads of 38 NMI signed a Mutual Recognition Arrangement (MRA) on mutual recognition of calibration and test results [3].

This Agreement is based on a long-term successful co-operation between national metrology institutes. It signals justified premature confidence in technical competence and well-functioning management. In order to guarantee such confidence in a lasting efficiency, the concept of bilateral and international co-operation pursued so far was supplemented by further elements.

Successful participation in key comparisons: they are organised by BIPM and the regional metrology organisations forming the basis of the confidence in metrological competence.

Operation of an efficient quality system by which the stability of the competence demonstrated by the key comparisons is guaranteed on the one hand and by which the working methods are made transparent on the other.

Implementation of the Agreement to metrological practice require great efforts by all the parties involved. At the same time it illustrates the benefits of intense international co-operation between the NMI over the years.

A direct transfer of this system of establishing confidence between the NMI to all the parties offering metrological services is hardly possible due to the large number of implications. With more than 230 countries recognised by the UNO and with more than 100 countries actively participating in world trade, harmonisation as well as the establishment of confidence is difficult. Therefore, more and more regional metrological organisations are being founded which bundle work forming the top level of a graduated system. Table 1 gives an overview of the regional metrology institutions of the world.

Table 1. International and regional metrology organisations

	organisation		task
international	BIPM OIML ISO/IEC ILAC/IAF IMEKO		units, standards legal metrology standardisation accreditation science, training
regional	Europe EUROMET EA WELMEC CEN/CENELEC	Asia-Pacific APMP APLAC APLMF	 units, calibration accreditation legal metrology standardisation

Whereas agreements to achieve equivalent working methods of the national metrology institutes are reached directly by these institutions, the establishment of confidence is in most cases performed at the level of standards calibration laboratories by accreditation of the laboratories concerned and mutual recognition of the results by bilateral agreements reached by the various accreditation bodies or regional organisations. Such agreements were reached by European co-operation for Accreditation (EA) A, for example, and therefore the bilateral agreements of EA will be replaced with an MRA under the umbrella of ILAC in the very near future.

OIML – the International Organisation of Legal Metrology - was established in 1955 in order to promote the global harmonisation of legal metrology procedures. Since that time the OIML has developed a world wide technical structure that provides its Members with metrological guidelines for the elaboration of national and regional requirements concerning the manufacture and use of measuring instruments for legal applications. It offers the so-called OIML Certificate System for Measuring Instruments, a voluntary system to promote the use of measuring instruments that comply with OIML requirements. The owners of such OIML certificates may use them, together with the accompanying test reports to have the patterns to which they refer approved more quickly and easily in countries where the instruments concerned are subject to legal control. Up to now about 600 certificates were issued under the OIML Certificate System

4 GLOBAL MEASUREMENT SYSTEM

It is the wish of all metrologists to realise a global measurement system. In this system all the measurements are supposed to be carried out **only once** by a competent body and recognized as being equivalent throughout the world. Not until this will have been achieved, double work will be avoided and time and cost will be saved. To reach this aim, however, an intense co-operation of all the parties involved will be required. A long and successful co-operation of the metrologists of the national metrology institutes forms a solid basis here. On this basis the mutual information about the regional and national metrological infrastructures have to be deepened, experience has to be exchanged, knowledge has to be transferred and confidence in the efficiency and quality of metrology have to be stabilised. Table 1 shows how the metrologists are trying to approach this aim by co-operating with standardisation organisations, accreditation, certification, and training bodies.

Metrological traceability and uncertainty of measurement.

Undoubtedly, traceability to SI units of measurement by reference to a suitable primary standard or to a natural constant is an essential element of the global measurement system. BIPM and all the NMI have dealt with these problems in a convincing manner. It is necessary in the near future to transfer

the complex projects to metrological practice and adapt them to the needs of the users and their demand for traceable measurements in an appropriate way.

Similar statements apply to methods for the calculation of the uncertainty of measurement. Over the last few years fundamental methods have been developed [4] and agreed upon as accepted methods for the determination of the uncertainty of measurement.

International Interlaboratory Comparisons

The international, regional and national interlaboratory comparisons carried out by the laboratories form the technical basis of a global measurement system. Within the framework of arrangements between the NMI they are called key comparisons being organised by the Consultative Committees of the CIPM of the BIPM and by regional metrology metrology organisations (RMO). Moreover, supplementary intercomparisons are carried out by the RMO which in their turn are directly coupled with the key comparisons.

Publication of the results and their permanent availability in a data base is an indispensable element of the establishment of confidence and a direct proof of technical competence. On the basis of the statements on the uncertainty of measurement pertaining to each intercomparison the degree of congruence of the measurements may be directly seen.

Quality Management

Another most significant confidence-creating element is the quality system. In the future, the quality system of an NMI will have to meet the requirements of ISO/IEC 17025 [5]. This standard, which will replace ISO/IEC Guide 25, came into force on the 1st of January 2000. As was agreed, a quality system on the basis of ISO/IEC 17025 along with a successful participation in the key comparisons will form the basis to be recognized world wide to have the competence for performing calibrations and tests. By continuous maintenance of a quality system and its implementation in daily practice it will be guaranteed that the competence of the NMI will demonstrably continue to exist in the period between the key comparisons. In this it is irrelevant whether the quality system was assessed by a third-party within the framework of an accreditation or whether the NMI has given a respective self-declaration. It goes without saying that mutual recognition is confined to the measured quantities, measurement ranges and uncertainties of measurement backed by key comparisons.

Proof of competence

To give proof of permanent maintenance of the above requirements and as a means to establish confidence, self-declaration and formal accreditation by internationally recognized accreditation bodies are used depending on the regional and national conditions.

At the level of the NMI the equivalent working methods are made transparent by direct measures agreed upon by the NMI. In most of the other cases this is normally done by committing the national accreditation systems to use equivalent working methods. The accreditation systems themselves are subject to international control by regular evaluations. In this there are clear regulations on how to achieve mutual recognition [6].

5 OUTLOOK AND BENEFIT

The efficiency of a well-functioning metrological infrastructure is a rather unspectacular process. Normally the key role which metrology plays in the success of economic developments, protection of health and environment, and last but not least, in influencing the development of the future will only become evident when the functioning of the measurement system is no longer satisfactory.

At present the development of metrology is characterized by the following requirements:

- The citizen is interested in correct measurements in trade, in safety technique, in environmental protection and in medicine
- The scientists want ever preciser traceable measurements, including the statement of an uncertainty budget
- Trade and industry want “one-stop testing” with world wide acceptance of certificates

It will be necessary to adapt metrology to the increasing requirements of science and technology as well as to the changing needs of the human being. In this we need new approaches for solving the problems of metrology in order to cope with the manifold challenges of the future.

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AUTHORS: Prof. Dr. Manfred KOCHSIEK, Physikalisch-Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig, Germany, Phone Int. +49 531 592 2000, Fax Int. +49 531 592 2002
E-mail: Manfred.Kochsiek@ptb.de
Dr. Andreas ODIN, Physikalisch-Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig, Germany, Phone Int. +49 531 592 8330, Fax Int. +49 531 592 8335, E-mail: Andreas.Odin@ptb.de