

LEGAL METROLOGY **at the Dawn of the** **21st Century**



**The Role and Responsibilities of the
International Organization
of Legal Metrology**

Knut Birkeland

Final version presented at the 33rd CIML Meeting (Seoul) – October 1998

CONTENTS

I. Foreword/summary	page 1
II. The changing world - does it change legal metrology?	page 3
III. The beginning of OIML	page 5
A. The purpose of OIML	page 5
IV. Global measurement system	page 6
A. The Convention du Mètre	page 7
B. OIML	page 8
C. ILAC	page 8
V. Briefly on modern legal metrology	page 9
A. Trade	page 10
B. Health service	page 11
C. Human safety	page 12
D. Environmental protection and pollution monitoring	page 12
E. Resource monitoring and control	page 13
F. Litigation and contractual legal requirements	page 14
G. Analytical chemistry	page 14
H. The main concern of OIML	page 15
VI. The current situation of legal metrology, two basic problems.	page 16
A. The Law	page 17
B. The enforcement	page 17
C. The exceptions	page 18
D. How the problems are reflected at the regional and international level	page 18
E. Of concern to OIML	page 18
1. The Law	page 18
2. The enforcement	page 20
VII. Globalisation of trade	page 22
A. A threefold challenge to OIML.	page 23
1. International compatibility of metrological regulations	page 23
2. Compatibility of conformity assessment	page 25
3. Agreements of mutual recognition of equivalence	page 27
VIII. Establishing mutual confidence in legal metrology	page 28
A. Accreditation	page 28
B. Measurement uncertainty	page 31
C. Equivalence of the reference standards of legal metrology.	page 31
D. Proficiency testing	page 33
E. Traceability in general	page 34
IX. Key comparisons and legal metrology	page 35
X. Training	page 37
XI. Economic impact of infrastructural changes	page 39
XII. International co-operation	page 41
XIII. Annex I	page 43
A. The WTO Agreement and the main current conformity assessment procedures in legal metrology	page 43
1. Type approval.	page 43
2. Verification	page 45
XIV. Annex II	page 46
A. Summing up efforts and initiatives to improve the efficiency and role of OIML.	page 46
B. Technical Committees and one ad hoc Working Group.	page 46
C. OIML liaisons	page 47
D. BIML Executive	page 48
E. CIML	page 48
F. CIML Executive	page 48
G. Improving the role of CIML Members	page 49
H. Improving the role of OIML	page 49
XV. References	page 49

Acknowledgement

I want to thank everybody, no one mentioned, no one forgotten (you are likely to recognise from the text how I have taken on your advice), who has helped me with comments and advise to develop this study from the first draft aimed at provoking thoughts and discussions about legal metrology and OIML, to this final draft aimed at better defining the future role and responsibilities of OIML, to enable the proper future contribution of OIML to the global consistency of measurement. Your help has been invaluable, without it my task would have been mission impossible.

KB

I. Foreword/summary

This is a study of modern legal metrology on the footsteps of the 21st century, its role and functions, its conditions.

I have tried to reach the objective by looking at current aspects affecting legal metrology. Modern legislation and deregulation, infrastructural changes, privatisation, technical and socio-economic development, globalisation of trade and internationalisation of information provided by measurement, it all affect and change the role, the functions and conditions of legal metrology.

In other words I have looked at legal metrology from the outside. From the inside it is not possible to see the wood for the trees, as old Heywood predicted in his Proverbs.

Even so it is easy to get lost in many important details.

At the end of the day two major factors stand out, both quite dramatically affecting legal metrology.

The first is basically a result of an explosive technical development making vast new areas available for measurement. Medical measurement used to be limited to temperature and blood pressure, now cancer treatment is monitored by measurement of radiation dose, ultra violet B measurement is available, and so on. Breathalysers and speed radar monitor safety. Pollution is monitored by measurement of exhaust, of CO₂, of airborne pollutants, of metals in water, of pollution from pesticides and toxic substances and so on. The maintenance of natural resources by monitoring quotas of oil, fish, etc., depend on credible measurement.

Many of these new areas where measurement has become widely applicable are areas of conflicting interest and areas where a high level of accuracy and confidence in the measurement result is appropriate from a political and socio-economic view. This is why most governments currently share an increasing concern for dependable measurement which affect the health, safety or legal rights of people, either individually or at large. The concern is strong enough to trigger a proliferation of new legislation and regulations of measurement, creating new areas of legal metrology.

Unfortunately, in general this new legislation is metrologically non-coherent and the implementing bodies are largely metrologically un-related and so, short of relevant, co-ordinated, underpinning infrastructure. Legal metrology is the common denominator, but the areas are otherwise largely un-related, professionally and metrologically, as are the regulators and the conformity assessors, in spite of the fact that "metrology is one of the few fields where a high degree of co-ordination is a rational and cost-effective thing"⁷⁾.

Moreover it currently creates unnecessary obstacles to international trade.

The second major factor affecting and fatefully challenging legal metrology is the globalisation of trade as well as of information provided by measurement. The enormous increase of international trade is conditioned by the WTO-requirement of not creating unnecessary obstacles. This is changing legal metrology. The globalisation is not limited to the trade of instruments, it include prepacked and bulk trade of commodities of enormous annual value, quantified by measurement. This dramatically increase the importance of enhancing international compatibility of regulatory requirements and of conformity assessment procedures in legal metrology.

This second major factor also include a growing but easily overlooked challenge to legal metrology. It is the need for substantial underpinning of confidence in measurement to support the growing internationalisation of exchange of information based on legal metrology measurement. One example is pollution. Pollution know no state boundaries and bi- and multinational agreements, such as the international trading of CO₂ quotas, are increasingly monitored by legal metrology measurement. The high socio-economic implications of such agreements require the highest level of compatibility and confidence in the measurements.

These two major factors and the optimalisation of confidence intended by legislating metrology require new strategies and new structural demands at the national level and deeper involvement at the regional and international level.

As these two factors affect legal metrology in a decisive way, they also affect the future role and responsibilities of the International Organisation of Legal Metrology (OIML). How OIML deals with this challenge will decide the future of OIML.

The objective of this paper is to better define the future responsibilities of OIML, to improve the efficiency and role of OIML, to enable its proper contribution to the global consistency of measurement.

The non-coherent legislation as such, simply implies a reinforced responsibility to advise decision makers and legislators on how to achieve metrological coherence in order to improve cost-efficiency and ensure that technical regulations related to metrology do not create unnecessary obstacles to international trade. No change of role for OIML.

To appreciate how deeply and comprehensively the extension of legal metrology into new areas affects OIML it is however essential to realise that only a few years ago, legal metrology simply was "weights and measures", and the founding fathers of OIML did not have to ponder over policy matters, everybody knew the role and responsibilities of legal metrology.

Since then many new subjects such as human health and safety, resource and environmental control and so on, have been thrown into the basket of legal metrology, for good measure. It has happened rather gradually, by stealth, the consequences were hardly perceived. Only over time it is realised that the role of OIML can not be the same for legal metrology in chemistry as for legal metrology in environmental control, as for legal metrology in retail trade. The responsibilities of OIML are in principle the same, but even so, they can not all be dealt with in the same way.

The challenge is therefore to enable OIML to assume its proper responsibilities of ensuring compatibility of technical regulations and of conformity assessment in all fields of modern legal metrology. To enable OIML to assume the leading role in modern legal metrology, OIML

will have to address the question of drafting a policy, the future policy of OIML, in each and every of the respective major new fields of legal metrology, health, safety, environment, chemistry, resources. This policy will have to include training and an uncompromising element of actively enhancing confidence in modern legal metrology. To succeed in this task it will have to be carried out in close co-operation with relevant and responsible partners targeted from the areas affected, as well as WTO and accreditation bodies such as ILAC.

The globalisation of trade and information will strongly affect the role and function of OIML, notably the TC's. The efficiency of the TC's must be enhanced by focusing the attention and efforts on the kind of metrological compatibility and equivalence of conformity assessment that will be required in the future.

Current broadening of legal metrology will also require restructuring of many TC's to become more topic-oriented.

Globalisation trigger and fuel regional co-operation, by far the most important current development of co-operation. As one of the purposes of OIML is to promote closer relations between bodies responsible for legal metrology, OIML will have to take on the leadership in creating the relevant corresponding inter-regional co-operation.

Moreover, additional to many other objectives, by regionally mixing industrialised and developing countries, the regional co-operation will also become the most efficient future tool for improvement of legal metrology in developing countries, and OIML will need to adjust its appropriate policy accordingly.

"The old era is ending. The old ways will not do"²⁾

II. The changing world - does it change legal metrology?

The most important current socio-economic changes may well be caused by the explosive increase in population, mobility and urbanisation. Combined with moral freedom to explore, to exploit innovation and creativity in the making of the tools for human survival and comfort, society is set for changes. Goods to be traded has to be measured over and over again many times on its way from the origin, the farmer or fisherman, the mine or oil well, to the consumer. Urbanisation powerfully fuel the rapid technical development of measurement. You need not to have been around that long to realise how the balances of the village shopkeeper and marketplace, gradually, through perhaps less than a generation, largely are replaced by digital non-automatic weighing machines and by automatic weighing instruments for pre-packed products. It is less than 40 years ago the present version of the metric system, the *Système International d'Unités* (SI) was adopted, to catalyse this development.

And the industrialised world is barely a few years ahead of the developing world.

During the same time we have gone from the analogue to the digital way of dealing with our measurements. Most people used to have an understanding of measurement, balancing the goods by the weights, realising there might be a small uncertainty associated. That understanding, that sense of measurement is now largely lost. It has been digitised away. Everyone can read the brightly displayed digits, taking the digits to be the truth and nothing but the truth. The measurement is obscure and there is no concept of measurement uncertainty⁷⁾.

This may seem to be a sorry loss to mankind, but to legal metrology a certain loss of the understanding of uncertainty may be a gain, it may even produce an added value by reducing costly disputes over measurement results.

In legal metrology the brightly displayed digits of a legally verified instrument actually represent the truth and nothing but the truth, regardless of the legally maximum permitted error of the measuring instrument. In court, the display of 1 kg means that the customer has to pay for 1 kg. Regardless of whether the real weight of the merchandise might have been between 995 g and 1005 g, legally displayed as 1 kg. Likewise, in court, the vehicle speed measured by the legally verified speed radar is as the brightly displayed digits of the instrument show, because the reading is within the unavoidable but maximum permissible instrument error.

On the other hand, increasing nominal value of commodities has created demands for greater measurement accuracy. There are far more measurements done today than ever before, the instruments are different and technically complicated, making the actual measurement obscure. Still we require higher accuracy!

The purpose of a measurement is to underpin a decision. Not only about the price of a commodity or to start dieting because of the reading of the bathroom scale. Measurement today allows for extensive decision making, on the strength of abundantly available digitised instrument readings. Important decisions. In diagnosis and therapy, in trade, in environmental protection, in resource protection, the latter often political decisions. The list is long and the decisions many.

These decisions are largely made on the strength of the measurements done by non-metrologists, at the user end of the metrological hierarchy. By the radiologist administering radio-therapy to the cancer patient. He knows his business, but hardly metrology. Most of these users have no alternative to take the instrument display for granted, and most certainly don't ask embarrassing questions about traceability, because they don't know what traceability is. More than ever do we need measurement in which all users can have confidence.

Real, not apparent confidence, that is. Which means that in areas where measurements are largely done by non-metrologists and where the decisions based on the measurements are considered important, increased attention needs to be focused on national and international compatibility of mandatory requirements to instruments and measurement methods and on compatibility of operational conformity assessment procedures and practices.

Society and metrology changes fast. Do the objectives and strategies, the know how and the material tools of the institutions, organisations and structures of metrology follow suit? Institutions and organisations have their own inertia, and certainly the metrological ones have. It takes a long time to establish metrological competence, a lot of resources to maintain it, and then it must all change and adjust! The conformity verification of the balance is developed to an art, are we as competently dealing with the automatic weighing instrument for pre-packages? Which requires a completely different technique. And what about the radio-therapeutical dosimeter, the gas analyser, the liquid chromatograph, the radar speed control instrument?

It is dangerously easy to lag behind, to serve yesterday's world instead of today's, neglecting to prepare for tomorrow's. To be boxed in by the trivial chores of every day and let the world change unnoticed, like the driver who concentrates on keeping his car on the motorway but doesn't notice the landscape he is driving through.

"Today there can be no status quo"⁽²⁾

III. *The beginning of OIML*

The two intergovernmental treaties on metrology

It is often heard that the origin of measurement, or at least of "weights and measures" is for consumer protection. This is overlooking that consumer protection is a very modern concept and weights and measures a very old one. The origin of measurement might rather have been for the protection of the ruler, to safeguard revenues and coinage, to measure the wages and rewards to be paid, and for the construction of palaces, pyramids and a calendar. Through the ages there were plenty of rulers and of measurement systems likewise.

The flourishing of trade about the middle of the 19th century was made possible by the second industrial revolution, the propeller driven steamship etc., and changed all that. It was found that the abundance of measurement systems were undesirable and unnecessary obstacles to trade, and were in principle abandoned by the very first scientific/technical intergovernmental treaty, the Convention du Mètre, signed in 1875.

The metric system, later developed into the *Système International d'Unités* (SI), gradually but unequivocally, replaced the abundance. Infrastructures were introduced for the dissemination of units and the implementation of the system.

At the international level, BIPM, and the other bodies of the Convention du Mètre.

At the national level National Metrology Institutes were established. Existing legislation on units and "weights and measures" were converted to the metric system.

So were the old National Weights and Measures Services.

Even so, at the level of applied metrology, technical barriers to the trade of measuring instruments still remained. In 1933 it was proposed to create a new Consultative Committee for Applied Metrology under the CIPM to address these questions. The following discussion clarified that the technical barriers to trade were caused by the absence of international compatibility in the regulated area, later known as legal metrology. Statutory and regulatory requirements for measuring instruments, issued by national authorities, were in general internationally incompatible, although largely based on the metric system.

Having identified the problems, CIPM decided this to be outside the scope of the Convention du Mètre. The compatibility problems nevertheless had to be dealt with, and the subsequent considerations lead to the signing in 1955, of the second intergovernmental treaty¹⁾ in the field of metrology, establishing the *Organisation Internationale de Métrologie Légale* (OIML).

A. The purpose of OIML

is to ensure international compatibility of technical regulations relating to metrology and of the corresponding conformity assessment.

The treaty determine how OIML will pursue its purpose. It include

- ♦ to study, with a view to unification of methods and regulations, the problems of legal metrology, of legislative and regulatory character, the solution of which is of international interest.
- ♦ the determination of the necessary and adequate performance characteristics to which measuring instruments must conform in order for them to be approved by Member States and for their use to be recommended internationally.
- ♦ to promote closer relations between departments responsible for legal metrology.
- ♦ to determine the general principles of legal metrology.

IV. Global measurement system

The mandate of this study asked for it to be based on the concept of a global measurement system as an essential tool for commercial, technical and societal progress in the 21st century. In order to be global, it can not be but one system.

So, what is the global measurement system?

And what might be the main characteristic of the global measurement system?

One key word is *availability*. The global measurement system must be available, to enable its use, to enable it to be taken advantage of. By all, par tous les peuples, pour tous les temps.

We are not there yet.

The extent to which the global measurement system is available varies widely, from countries with a comprehensive and cost-efficient national measurement infrastructure, all the way to countries where nothing but a Law on units and some traditional working standards for checking market scales may exist, but not much else. No infrastructure, no standards or conformity programs whatsoever to underpin the global measurement system.

In those countries an essential tool for progress is not available. Not yet.

Another key word is *confidence*. It is maintained that "*A system of measurement in which all users can have confidence is an essential part of the climate which business needs*"^(B)

Business is far from the only area where confidence in measurement is needed. Industry needs it to reduce costly duplication of conformity assessment. Science and research needs confidence to enable comprehensive exchange of information. Environmental protection need it to reduce costly and time consuming legal or political disputes over measurement results. Resource protection likewise, human health and safety needs confidence. The list can be made very long.

What is a system of measurement in which all users can have confidence?

Who are all these users in need of confidence? Well, that's you and I, whenever we check the time by the wrist watch, hurrying to an appointment. It is the nurse using an electrocardiograph to measure your heart activity, and yourself, whose heart activity is measured. It is the policeman using the radar to measure the speed of the car, and you, the driver of the car. Even in the remotest areas people do not trade rice by counting grains, they measure it by weight or volume, they need confidence in the measurements. A system of measurement in which the negotiators of trade and mutual recognition agreements can have confidence is an essential part of the climate which such negotiations needs. Countries trading CO₂ need to have mutual confidence in the measurements.

The users who needs confidence are all of us, individually or at large, wherever we are, whatever we do.

The demands on confidence are high, after all it is about money, heart rate, time, knowledge. And above all, apart from the few who know a bit about measurement, the vast majority of other users know next to nothing about instruments and measurement.

That's the perspective one need to have on confidence in measurement.

It may be useful to resort to a generally accepted concept of what the global measurement system purports to provide. How about:

- ♦ *The global measurement system provides a coherent structure which ensures that measurements can be made on a consistent, appropriately accurate, transparent and internationally recognised basis throughout the world. It comprise all activities that provide measurement data as a basis for decisions in many aspects of life - politics, commerce, industry, science, engineering, international trade, human health and safety, environmental and resource protection.*

What are the essential elements of the global measurement system? The most obvious are:

- ♦ the SI,
- ♦ extensive, active international and regional co-operation in metrology,
- ♦ coherent legislation based on the SI,
- ♦ appropriate physical realisation of the units of the SI, all the way from the international realisation of the basic and derived units, through the national measurement standards down to the working standards used for calibration or conformity assessment,
- ♦ traceability,
- ♦ calibration,
- ♦ compatible and operational conformity assessment procedures and practices,
- ♦ validation of competence and traceability of conformity assessing bodies,
- ♦ training,

The availability of the global measurement system is obviously dependent on the existence of appropriate international as well as national infrastructures, i.e. the technical and organisational components of metrology.

The international infrastructure is based on three pillars.

A. The Convention du Mètre

The basic pillar is of course the technical and organisational components related to the Convention du Mètre, BIPM and the National Metrology Institutes, developing and providing the Système international d'Unités, SI, which is the cornerstone of the global measurement system, and the SI-based international and national measurement standards.

- ♦ The tools are comparison, calibration, traceability, research and development.
- ♦ Current infrastructural priorities are
 - an extensive program of key comparisons to demonstrate the degree of equivalence of national measurement standards and
 - a promotional program of mutual recognition of national measurement standards and of calibration certificates issued by national metrology institutes.
- ♦ The users are largely metrology experts in science, industry, services and legal metrology.

Needless to say that these are the fundamental elements of the global measurement system without which all other elements would fail.

B. OIML

The other pillar is OIML, providing metrological requirements and guidelines for internationally compatible operation of legal metrology

- ♦ The tools of OIML are international expertise in legal metrology and in creating internationally compatible metrological requirements.
- ♦ Current infrastructural priorities of OIML, pending decision by CIML (see Annex II)
 - to draft the future policy of OIML in major new fields of legal metrology.
 - to improve the efficiency of OIML in providing relevant metrological requirements, focusing on compatibility of conformity assessment procedures and practice.
 - to improve efficiency of training programs in conformity assessment procedures.
 - promoting programs of mutual recognition agreements of OIML Certificates and of equivalence of national regulations, conformity assessment procedures, reference standards and OIML compliance documents.
- ♦ The users are largely the metrologically not competent layman, user of measurement instruments subject to regulatory control, generally in commerce and international trade, human health and safety, pollution and resource control.

C. ILAC

The third pillar is a relative newcomer, ILAC, serving modern transparency and confidence building, promoting and providing internationally uniform implementation of the ISO/IEC harmonised requirements and guidelines for third party assessment of the technical quality, competence and traceability of operators in the field of metrology.

- ♦ The tools of ILAC are third party assessment based on internationally agreed requirements and practices.
- ♦ Current infrastructural priorities are programs of promotion of
 - mutual regional recognition agreements of equivalence of accreditation by national accreditation bodies
 - inter-regional recognition agreements of equivalence of regional recognition agreements
 - mutual recognition agreements of certificates issued by accredited laboratories.
- ♦ The users are largely industry and services, increasingly also metrology and research institutes, legal metrology bodies as well as governments for the particular purpose of minimising technical barriers to trade.

Underpinning the three main pillars of modern metrology are a great number of organisations, with interest in metrology and depending on the global measurement system, but with other main objectives.

It must be appreciated that it is not possible to take advantage of the global measurement system unless a minimum of metrology infrastructure is in place at the national level.

Even when that is the case, the global measurement system is not always used. In many cases short time consistency and local reproducibility is all that is required of metrology and strict adherence to the global measurement system may just overshoot the mark.

In other cases metrological incompetence, insufficient co-operation, non-coherent legislation and enforcement by multiple un-related authority leaves a great deal to be desired when it comes to take advantage of the global measurement system.

V. *Briefly on modern legal metrology*

What is so special about legal metrology? Not metrology. It is the legal aspect that is special. Metrology becomes legal metrology when legislators introduce mandatory legal requirements to units of measurements, methods of measurements and of measuring instruments. The objective is to ensure an appropriate level of credibility and confirmed accuracy of measurements⁵⁾.

The relevant legislation or regulation is considered the responsibility of the government, a responsibility to be implemented *by or on behalf of* the government, hence Legal Metrology. The Legal Metrology bodies are the Regulatory Authorities as well as the Conformity Assessment bodies in *all* fields where measuring instruments and measurements *are subject to governmental or official regulatory control*.

Not so special but equally important is that legal metrology is carried out at the end user level of the hierarchy of metrology. It is the very "bottom up" of metrology and is directly concerned with the measuring instrument or the measurement result of *the non-metrologist user*.

At the core of legal metrology are the areas of conflicting interest and areas where special confidence in the measurement result is required. In our technically, economically and politically complicated world the areas of conflicting interests and areas in need of high confidence are many, even if we are only talking about metrology. Measurement in which all users can have confidence has always been the main concern of legal metrology.

Legal metrology makes certain measuring instruments and measurements subject to governmental or official regulatory control. The tool to achieve this is an operational and impartial infrastructure of conformity assessment procedures and practices.

The extent of metrological legislation and regulation and in particular the quality and penetration of the implementation of conformity assessment differs widely between countries and is symptomatic of pragmatic governmental concern for the legal rights of the population.

Most governments share a concern for consistent and dependable measurement where it may have a substantial economic importance for the country or affect the economy, health and safety of the population, either individually or at large.

In most countries in the world, industrialised as well as developing, you will find various degrees of *regulatory control* of metrology in all of the following areas, thus constituting the main areas of modern legal metrology

- ♦ trade and commerce, retail, wholesale, bulk, domestic, cross-border and international (weighing, volumetric fluid measurement, etc., etc.)
- ♦ fiscal control, revenue collection
- ♦ services (taximetry etc.)
- ♦ utility metering (water, gas, electricity)
- ♦ contractual legal requirements
- ♦ health service (thermometry, radiotherapy, blood pressure etc.)
- ♦ human safety (speed radar, breath analyser, toxic measurement, etc.)
- ♦ environmental control, pollution (vehicle exhaust, pollution quotas, noise, etc.)
- ♦ resource control (fishing quotas, oil quotas, energy, water, etc.)

This is not to say that the National Legal Metrology Service of any country covers all of the main areas of legal metrology. Quite the contrary. It is usually by legislation restricted to certain sectors. In some cases with little or no authority or advisory role in the modern fields of legal metrology, where new forces are active in regulation, and conformity assessment.

A. Trade

In most countries goods of a value of between 60% and 80% of the GNP are traded, generally by repeated measurements on its way from producer to consumer, by instruments subject to various kinds of mandatory, regulatory control, i.e. legal metrology.

It include the whole range of trade, from retail and utility trade through wholesale to international trade. As always in trade, there is an important element of conflicting interest involved between buyer and seller, justifying relevant legislation.

It is easy to realise the importance to the personal economy of the measurement of consumer goods at the retail market place or the petrol dispensing pump etc. The social significance of enabling consistency of confidence in appropriate accuracy of measurement in the retail market is not to be underestimated and operational conformity assessment programs of legal metrology is well developed and practised in this area.

It is equally easy to realise the importance to the personal economy of measurement of electric power, water and gas in the utility market. In most countries there are mandatory technical and legal requirements to the units of measurement, methods of measurements and to the measuring instruments applied in the utility field, i. e. legal metrology. Utility meters represent however a particular challenge to legal metrology because of the level of partiality generally accepted in many countries in the practising of conformity assessment as this is usually done by the seller of the product to be measured, be it electricity, heat, gas or water. It is conveniently maintained that statistically wrong measurement evens out, which is fine for the seller. For the customers who are wrongly overcharged, it is hardly equally fine.

Lack of a structures of cost-effective, impartial conformity assessment in which the consumer of utility products can have confidence, is a shortcoming.

Technical development enables commodities to be automatically measured and prepacked for trade, the globalisation of trade has made prepacked commodities abundantly available everywhere. Australian wine is bottled for sale in France, French wine bottled for sale in Australia, Portuguese sardines tinned for sale in the US, costly Arabian spices and Indian tea packed for sale in Europe, Thai rice bagged for sale in China. The mandatory regulatory control of automatic prepacking machines has introduced a new dimension to legal metrology conformity assessment.

Comprehensive bulk trade measurement for export or import of millions of tons of mineral or agricultural products and millions of m³ of oil and gas directly affect the economy both at the national and the individual level. These measurements are of utmost fiscal and economic importance, sometimes even the very economic backbone of many countries and are largely covered by various technical and legal metrological requirements and legal metrology conformity assessment programs.

B. Health service

Technical development of measuring instruments for diagnostic and therapeutic purposes has been impressive during the last few decades and the development is accelerating into the 21st century.

Measurements in the health service are instrumental to the quality of life, even to life or death of all citizens. Their accuracy may sometimes literally mean life or death. How many thousands of cancer patients have been successfully treated each year by metrologically accurate radiotherapy? How many lives were unnecessarily lost because unchecked, inaccurate instruments used in radiotherapy gave them too much or too little radiation?

Most governments feel an increasing concern for credible, consistent and appropriate accuracy of measurement in the health area and feel justified to develop quite extensive regulatory measures including mandatory metrological requirements, making the health area a fast growing concern to current legal metrology. The prevention of unwarranted litigation is another justification for governments to introduce mandatory metrology-related regulations in the health area.

Of course not all instruments used in the health service are or will be subject to legislation, but in all countries there are at the least some basic legal metrological requirements relevant to the health service, starting with clinical thermometers and continuing with sphygmomanometers to measure our blood pressure, it gives us precious information about our health situation. Many countries currently continue to include in their legislation instruments for diagnostic purposes, such as electrocardiographs to measure our heart rate, instruments to serve therapeutic purposes, such as dosimeters, used in radiotherapy, etc., just to mention a couple.

The health service is an area where complicated instruments are used by medical specialists, not metrologists, often with a shortage of knowledge at the point of use of the need for systematic programs with an acceptable integrity, for checking instrument accuracy. An area where lack of measurement accuracy not only may hurt people economically but also physically. It is also an area where both parties of a measurement, the medical personnel and the patient are equally interested in the accuracy if the measurement, at least unless a compensation claim for maltreatment is developed, in which case conflicting interests will interfere.

The ongoing development of the contribution of legal metrology to ensure the appropriate accuracy, to ensure confidence and consistency in the measurements, is a long-term challenge. The eagerness of the legislators to regulate is not always matched by an equally impressive eagerness to enable adequate infrastructural support to metrology in the field of health service. Some countries have however been able to establish a good contribution to meet the need for a metrological follow up of the legislation, others are systematically developing their efforts, in other countries again the field may still largely be somewhat neglected.

C. Human safety

Technical development continually increase the possibilities to monitor human safety by measurement and human safety is increasingly depending on accurate measurement and systematic metrological monitoring.

The police radar speed measurement and the breathalyser monitor our safety on the road, manometers for pressure vessels, dosimeters for radiation, load cells for strain in building

constructions, light meters and sound level meters all monitor our safety at the place of work, chemical metrology monitor food and toxic substances, instruments in ships and aircraft monitor safety when travelling, just to mention a few.

As these technical solutions focused on the protection of human safety, when travelling, on the road, at the work place, etc., continue to develop, so do the possibility to enable confidence and consistency of appropriate accuracy by legislation.

Again, not all measurement in the field of human safety are important enough to justify legislation, and besides, no one can really tell how many lives have been saved by the preventive use of police radar. It is however an area largely considered by relevant legislation, including metrological requirements, both for protecting health and life of people, to prevent as far as possible expenses to the health service and traumas to individuals caused by accidents and also reducing conflicting interests with their unavoidable costs to individuals and society. It is an important and growing concern to current legal metrology.

It is an area where co-ordination of infrastructures in a metrologically meaningful way, jointly taking advantage of international compatibility, of shared traceability chains, of sharing experience in the regulatory and conformity assessment areas, of delegating implementation of the legal requirements to accredited conformity assessing bodies, may be a rational and cost-effective way for legal metrology of contributing to human safety.

D. Environmental protection and pollution monitoring

The field of environmental protection and pollution monitoring is heavily regulated and is already one of the most important measurement activities of modern legal metrology. The measurements are often of complex nature, involving both physical and chemical metrology. Conformity assessment is equally demanding.

The measurement results can have the most important social and economic consequences. How many thousands of lives are made safer and more comfortable by dependable pollution monitoring? And how many questionable decisions with costly consequences have been taken based on unchecked, inaccurate instruments used for monitoring pollution? Appropriately accurate instruments validating confidence in pollution measurement becomes a major issue, justifying legislation.

Nations discuss environmental reforms and bi- and multilateral agreements of great consequence, underpinned by measurements by pollution monitoring instruments. Currently there are few statutory requirements for cross-border comparisons of these measurements, but this will gradually change, triggered by impacts like the CO₂ trade agreement and to prevent major international conflicts under future agreements.

At the national level legislation use measurement as a tool to monitor man-made harmful pollution, control conflicts with polluters and to evaluate the economic balance between polluting and less-polluting economic activities.

Currently a range of fiscal tools is beginning to be activated to reduce harmful pollution. The 21st century will without doubt see a strong, further development of the use of fiscal tools for this purpose. To make it work it will have to be underpinned by legal metrology activities.

One should not overlook that this is an area of high cost-efficiency. Just compare the cost of adequately monitoring a nuclear power plant by the relevant measurements by verified instruments with appropriate accuracy, with the human and economic cost of a pollution catastrophe.

The importance of metrology as a tool for environmental protection and pollution monitoring will strongly increase in the 21st century, and will draw a lot of political and public, economic and legislative attention to measurement.

E. Resource monitoring and control

As the planet threaten to run out of many precious resources, basic for the production of energy and food, such as water, minerals, oil and gas, fish and so on, both prices and political interest in resource control tend to increase. This will demand more measurement and measurement of high credibility and accuracy.

Many countries have a growing concern for dwindling natural resources, be it fish, minerals, oil and gas, often of vital fiscal and economic importance. There is a growing awareness about how legal metrology can contribute effectively.

As a consequence, countries increasingly legislate resource monitoring and control based on appropriately accurate legal measurement. This will become one of the most important areas of legal metrology in the 21st century, on par with trade metrology and the metrology of environmental control.

The importance of this issue is underpinned by the Resolution 1 of the 20th CGPM in 1995, about the need to use SI units in the field of resource studies.

There are two important fields of resource control, the measurement of:

- ♦ non-regenerating resources (minerals, oil, gas, etc.)
- ♦ regenerating resources (water, fish, etc.)

One example is a recent development of special belt weighers particularly adapted for weighing freshly caught fish, on shore or on trawlers at sea. The high accuracy obtained with these belt weighers compared to all other methods of quantifying the fish, makes them ideal as means to monitor agreed bi- or multilateral fishing quotas.

In some fishing waters they already serve this purpose⁶⁾.

Legal metrology of course contributes to the maintenance of the accuracy of these instruments and the confidence in the measurement results by programs of conformity assessment. This is one example of how legal metrology contribute to a rational resource control.

In the control of the "withdrawal" of natural resources, minerals, oil, gas, etc., bulk measurement is a fundamental element, a classical area where legal metrology has comprehensive experience and technical competence.

In this area, perhaps more than in any other area of legal metrology a pragmatic and efficient cooperation is required between legal metrology and other governmental authority, responsible for the area of resource control where accurate and credible measurement is vital.

F. Litigation and contractual legal requirements

A special but growing area where legal metrology mainly plays a preventive role is litigation. In some cases regulatory control of measurement is introduced by the authorities to reduce unwarranted litigation, particularly in the health and safety area.

It should not be overlooked that particularly in the areas of health service, human safety and pollution control, litigation, where measurement is of decisive legal importance, is a concern to legal metrology.

Another is contractual legal requirements where measurement are concerned.

G. Analytical chemistry

It is important to realise that there is no principal difference between metrology in chemistry and metrology in physics. The global measurement system, traceability etc. is just as important in metrology in chemistry as it is in physics, however possibly more difficult to achieve. One of the main problems is the vast range of chemical analysis undertaken and the potential standards burden this entails.

"The determination of the chemical composition of a material by analytical measurement has developed primarily to meet the needs of trade. Agreement on composition remains of crucial importance to commerce as many decisions taken in national and international trade depend on the compliance of goods with contractual or statutory requirements derived from chemical analysis. Many of these measurements play a vital part not only in ensuring the quality of goods and commodities but also in the development of Government policy in areas as diverse as revenue collection, health and safety, environmental protection, agriculture and law enforcement.

It is estimated that approximately 1000 million analytical measurements are carried out each year, only in the UK.

The problem of the validity of analytical data - and the need for clear and unequivocal means to demonstrate that validity - has become increasingly apparent in recent years"³⁾.

It is already some years ago that the bodies of the Convention du Mètre opened up for metrology in chemistry to take advantage of the global measurement system. First by including the mol in SI. Later, in 1993, the CIPM created the Comité Consultatif pour la Quantité de Matière to establish primary methods for measuring amount of substance, international comparisons and traceability between national laboratories concerned with metrology in chemistry.

There is an abundance and proliferation of statutory requirements and provisions concerning metrology in chemistry, making metrology in chemistry an important and growing area of legal metrology, and indeed a growing concern to OIML and the Technical Committee 17, Instruments for physico-chemical measurements.

Considering the vast areas of important activities of legal metrology in chemistry, heavily involved in:

- ♦ GLP
- ♦ environmental monitoring
- ♦ national and international trade in food and drugs

- ♦ human health and safety
- ♦ forensic medicine
- ♦ resource monitoring
- ♦ law enforcement
- ♦ revenue collection
- ♦ and the list can be made very much longer,

H. The main concern of OIML

When OIML was envisaged, legal metrology largely was "weights and measures", the attention was focused on reducing technical barriers to trade. The founding fathers did not have to ponder policy matters, everybody knew the role and responsibilities of OIML. Few foresaw the development of legislation and regulation of metrology that was to come.

Over the years new legislation has thrown the many new subjects into the basket of legal metrology, for good measure. It happened rather gradually. The consequences for OIML were in the beginning hardly perceived. The gradual inflow of new subjects to legal metrology has over time led OIML to build up a series of new Technical Committees, all traditionally instrument-oriented, with no underpinning OIML policy or particular topic-built strategy, and with vague user-relation. Only over time it is realised that the role and function of OIML can not be the same for legal metrology in chemistry as for legal metrology in environmental protection, as for legal metrology in retail trade. The responsibilities and purpose of OIML are in principle the same, but even so, they can not all be dealt with in the same way.

Unlike traditional legal metrology, where most or all instruments are subject to regulatory control, the new areas are only partly regulated. Mainly where a particularly high level of conflicting interest or a demand for confirmed accuracy justify regulation. For this study it is immaterial where the line is drawn between legal and "non-legal" metrology. In this context it is important to look at the future role, objectives and contribution of OIML.

The new areas are all characterised by the usual problems caused by inconsistent, fragmented and non-coherent legislation, with metrologically un-related regulators, implementing bodies and user groups. It impedes a rational use of the global measurement system and cost-effective compatibility.

It also means that an OIML policy in the new areas must actively address and engage the new users, the new regulators, the new conformity assessors. To avoid fragmentation of efforts the OIML system of Technical Committees must be reoriented, perhaps even restructured, towards a more topic-oriented and not as present, exclusively instrument-oriented activity.

The users, the regulators and the conformity assessors of traditional legal metrology laid the framework and general principles for how OIML should deal with traditional legal metrology to pursue its purposes of establishing national and international compatibility, credibility and appropriate accuracy. Now the new users, regulators, assessors of the new areas of legal metrology must be involved in laying down the policy and principles of how OIML should pursue its purposes in all fields of modern legal metrology.

It must be appreciated that nothing will be achieved if the people it concerns is not involved. And it must not be developed so that OIML achieves by pushing traditional ways upon new users, it must be the people it concerns, who satisfy *their* need for national and international

compatibility, credibility and appropriate accuracy through OIML, propelled by the efficiency and leading role of OIML.

The biggest current challenge may be to enable OIML to assume its proper future responsibilities and role by addressing the question of drafting the future policy of OIML in each and every of the respective major new fields of modern legal metrology, health, safety, environment, resources and chemistry. This is a comprehensive task that will have to be inspired by new and creative thinking and carried out in close co-operation with relevant and responsible partners targeted from the areas affected.

In conclusion

- ♦ *In order to enable OIML to assume its proper responsibilities for promoting international compatibility in all fields of legal metrology, OIML will have to address, in close co-operation with the respective users, the question of drafting the future policy of OIML in the fields of*
 - *legal metrology in health*
 - *legal metrology in safety*
 - *legal metrology in environmental protection*
 - *legal metrology in resource monitoring*
 - *legal metrology in chemistry*

VI. The current situation of legal metrology, two basic problems.

In spite of a general trend towards deregulation, the growing governmental concern for consistent and dependable measurement, has led to a proliferation of national statutory regulation in metrology.

Existing legislation on units and on "weights and measures", if considered at all, has often been judged unfit to incorporate statutory requirements to instruments and measurements for medical diagnosis and therapy, monitoring pollution and human safety and so on. New legislation is frequently created ad hoc, often with no relation or reference to existing legislation related to metrology.

Fragmented, non-coherent legislation and modern trends of privatisation and delegation, has created a general situation of multiple authorities, a number of new Legal Metrology bodies having executive power by notification or other delegation. Such as instrument manufacturers delegated the right to do type approval and/or initial verification as well as private bodies delegated to operate conformity assessment programs.

As a consequence two basic and closely related problems are facing modern legal metrology at the national level,

- 1 The Law. Fragmented, non coherent laws on metrology,
- 2 The enforcement. Non-uniform, sometime non-operational conformity assessment procedures and programs, enforced by multiple, un-related authorities.

With some notable exceptions, these problems are largely similar, but to various degrees, both in industrialised as well as in developing countries.

This is the less satisfactory non-coherent and un-related multiple authority extreme of what should have been "a system of measurement in which all users can have confidence".

The objective of promoting international conformity in legal metrology make these two problems of primary importance to OIML.

A. The Law

The basic problem is that most countries today suffer a fragmented, non-coherent legislation as regards metrology, and continue to develop this in an ad hoc, non-coherent way. Internationally recommended metrological requirements are not taken advantage of. The legislators are naturally not focused on metrology but rather on the particular concern, such as the health service or environmental protection, not adequately addressing the measurement of the relevant parameters and sometimes oblivious to any need for programs of traceability and conformity assessment.

The problem is not so much the fragmentation, but rather the resulting lack of metrological coherence.

Addressing this problem is of particular relevance and urgency to OIML.

One of the purposes addressed by the treaty¹⁾ establishing OIML is "to study, with a view to unification of methods and regulations, the problems of legal metrology, of a legislative and regulatory character, the solution of which is of international interest".

B. The enforcement

The other problem is that this legislation as a result of the fragmentation, is enforced by multiple, largely un-related authority. It is often multiplied by the current trend of privatisation, and not always underpinned by relevant metrological competence. It is frequently operated within closed systems, based on local and short time consistency and reproducibility, often with vague if any statutory or traceability links to a national measurement system, linked to the Convention du Mètre and SI.

The problem is not necessarily multiple authority, but rather the lack of operational metrological inter-relations.

It has to be clearly stated that it is unimportant whether it is a governmental or private body implementing legal metrology, as long as impartiality is assured and they are all competently and credibly able to take full advantage of the global measurement system. The general experience however is that not all of the new conformity assessment bodies acting in the modern fields of legal metrology, health, safety, pollution monitoring, etc., have metrologically adequate operational conformity assessment procedures or programs to provide the intended confidence. This may be fine from the point of view of minimising obstacles to trade, but is not so fine for the confidence intended by the legislation that made it into legal metrology. Compared to the infrastructures usually underpinning the competence and credibility of traditional legal metrology, such as measurement standards, calibration programs, traceability and sometimes accreditation, there are rather comprehensive shortcomings in some areas. Short time consistency and local reproducibility may turn out to be all that is available, but in the 21st century that is never going to give satisfaction to even the simplest requirements of confidence in cross-border or international trade nor in cross-border or international exchange of measurement information, neither in health, safety, pollution, etc.

Another of the purposes of OIML is "to promote closer relations between bodies responsible for legal metrology"¹⁾, making this an equally relevant challenge to OIML.

C. The exceptions

Having drawn the attention to these two basic problems largely related to the development of new areas of legal metrology, it is however important to appreciate that a few OIML Member States, with an efficient metrological infrastructure, often with a centralised base, constitute significant exceptions to the general situation, enjoying a high level of coherent legislation and uniformity of enforcement.

It is also significant that in very many Member States the existing traditional legislation on units and "weights and measures", as stand-alone legislation, usually still serves its intended purpose and that the corresponding programs of conformity assessment, are not only operational but of high competence and integrity, mostly meeting high standards of national uniformity.

As for international compatibility there still may be a deal left to be desired. Even so, traditional legal metrology is by far the area closest to minimising technical barriers to trade and to meet the requirements of mutual agreements of recognition of equivalence of conformity assessment procedures.

D. How the problems are reflected at the regional and international level

The fragmented legislation and non uniform enforcement generate major technical barriers to trade caused by lack of conformity of regulations and conformity assessment as well as barriers to trade caused by lack of confidence in the measurements. These barriers to trade are of quite other orders of magnitude than those that once initiated the creation of OIML. It prevents timely preparations for mutual recognition agreements of conformity assessment and subsequent implementation of trade agreements based on minimising obstacles to trade . Governmental and official regulations are without exception real and potential obstacles to trade, unless regionally and ultimately internationally compatible, which of course begins with co-ordination and coherence at the national level.

Equally important is that it prevents the exchange of credible and comparable measurement results as a basis for decision making in areas with growing emphasise on metrological confidence and transparency, such as in international pollution monitoring.

E. Of concern to OIML

1. The Law

The fragmented development of non-coherent national legislation related to metrology is of particular relevance and concern to OIML. It is in conflict with the objectives of the Organisation as far as promoting legislative coherence is concerned.

To address this problem OIML should give the very highest of priority to the urgent revision of the International Document 1, Law on metrology. This will require dedicated efforts.

The OIML International Document 1, Law on metrology, has already been outdated for some time both as far as scope and objective is concerned and in its form as guidance document.

Many Member States and Corresponding Members as well as countries not yet associated with OIML are currently revising their Laws on metrology, particularly motivated by the globalisation of trade. This makes a revision particularly urgent.

A revision is of equal importance and urgency to industrialised and developing countries, but when addressing the task it must be taken into account that it is a different problem to introduce coherent new legislation in a developing country and to reform a developed system.

A revision must give full consideration to the consequences of

- ♦ current governmental concerns that presently is broadening the scope of statutory regulations and requirements relating to metrology and
- ♦ WTO requirements for international compatibility and minimising obstacles to trade.

A revision must provide guidance, primarily relevant to legislators, as to adequate ways to achieve and maintain metrological coherence, appropriate accuracy and the essential links to the global measurement system.

The Law on metrology is basic to legal metrology, but it is hardly for the metrologist to legislate. It is the responsibility of the politician and legislator to determine when the concern for consistent, credible and appropriately accurate measurement and international compatibility, is such as to justify legislation.

That it is a political responsibility is clearly shown by the wide difference in national legislation related to metrology, depending on the national political and socio-economic situation at any time.

In most countries we have already seen a proliferation of legislation as technology gradually enable measurement in areas of growing political concern about human health and safety, environment and resources. We will see a further development of statutory and regulatory control of measurement as politicians of the 21st century will begin to use fiscal tools more extensively to enable a certain level of control over pollution and the consumption of energy and resources. Monitoring will increasingly have to be underpinned by legally valid measurements, both at the national and international level.

The role of the metrologist is to anticipate socio-economic development, to initiate and provide relevant guidance to the legislators. To initiate and provide consequential analysis and guidance on realistic, cost-effective infrastructural needs to underpin legislation. In order to initiate meaningful legislative activity and assure legislative relevance, coherence and efficiency.

A modernised OIML guidance document on Law on metrology, firmly based on the general principles of legal metrology, is urgently needed by the legislators to coerce legal metrology. The revision of D1, Law on metrology, is currently the responsibility of Technical Committee 3. Apart from Technical Committee 9, this is the technical committee of OIML with the strongest participation. It includes both Member States with badly fragmented, non coherent legislation, Member States with coherent legislation and uniformity of enforcement and developing countries currently addressing the question of establishing a national Law on metrology.

In conclusion

- ♦ *In view of the present lack of legislative coherence in legal metrology, Technical Committee 3 should urgently revise OIML Document 1*

2. The enforcement

The lack of coherence and uniformity of conformity assessment procedures operated by multiple, un-related authority is also of particular relevance and concern to OIML. It is conflicting with the objectives of the organisation, which include to promote closer relations between departments responsible for legal metrology¹⁾.

The endeavours of OIML to pursue the objectives of promoting closer relevant relations, goes on at many different levels.

Efficient international liaisons are an obvious must. The focus on developing relations at the international level, between OIML and other international and regional organisations, result in commendable achievements.

For example is an excellent liaison enjoyed between OIML and WHO. But - for other purposes than to provide sufficient relevant expertise from Member States to contribute to the elaboration of OIML International Recommendations on medical instruments. Nor is the objective to bring the medical profession to implement the Recommendations in question. When both production and customer fails, the obstacles to trade persist and the global measurement system is not taken advantage of in a rational and cost-effective way.

As for promoting closer relations between departments responsible for legal metrology in each of the Member States, it has been most successful in the fields of traditional legal metrology. Both the CIML and the Technical Committees are fora for close and purposeful relations, largely between the departments representing traditional legal metrology in each Member State. Bodies representing fields of modern legal metrology in each Member State are perhaps not yet sufficiently challenged by compatibility requirements, the strongest incentive to closer relations within the scope and objectives of OIML.

In other words, OIML promotion of closer relations between responsible bodies in the modern fields of legal metrology by working together in Technical Committees and Subcommittees for ionizing radiation, for measuring pollutants, for physico-chemical measurements, for medical instruments and so on, is not yet as successful as OIML promotion of closer relations by co-operation in the Technical Committees for mass and quantities of fluids. The promotional programs that are successful in traditional legal metrology does not work as well in the modern fields.

OIML need to refresh promotional strategy.

The same, including the need to refresh promotional strategy, is currently the case as regards OIML concern for promoting closer relations between bodies responsible for different fields of legal metrology within each Member State.

The CIML member represent legal metrology in his country. Not limited to his own position or institution, but all areas of current legal metrology. He will entertain the relations between all bodies responsible for legal metrology in the country. He will encourage contribution to the different activities of OIML, notably the Technical Committees and Subcommittees. He will distribute drafts for contribution and comments. This may work very well, particularly in Member States with a strong infrastructure. In other Member States, where traditional administrative and communication systems complicate co-operation, where the CIML member is

not given the mandate or possibility to promote co-operation, the relations may leave much to be desired.

Shortcomings in relations and co-operation at the national level are detrimental for the creation of uniformity and compatibility. It constitutes obstacles to the timely replacement of technical barriers to trade by internationally compatible requirements and timely material preparations to agreements of equivalence.

It is also an important disadvantage to the technical activities of OIML as it curtail access to the expertise needed for the elaboration of metrological requirements to be recommended internationally in the fields of modern legal metrology.

There are unsolved problems at the national level that need to be addressed but the nature of the problems suggest that solutions are not easy to find at the national level.

OIML will have to address it. It affects both the resources available for the appropriate contribution of OIML to international compatibility and the degree to which the global measurement system can be taken advantage of as a tool for progress.

OIML will have to reconsider and strengthen support to CIML members in their endeavours to establish efficient relations with other departments responsible for legal metrology in their respective countries.

To enable the CIML member to have the full overview over all areas of current legal metrology in his country it is essential that

- ♦ all legislating and regulatory bodies relevant to metrology, are identified and registered.
- ♦ all legislation and regulations, all mandatory technical and legal requirements related to instruments and metrology, are identified and registered.
- ♦ Likewise should all bodies who are delegated the responsibility to enforce such technical and legal requirements, be identified and registered.

In many Member States this has been done and there it gives the CIML Member a powerful tool to promote relevant and close relations. In many Member States it is not yet done or the information is not taken advantage of.

In some Member States promotion of closer relations is developed by the establishment of a National Legal Metrology Society, to create a forum for relations between legislating and regulating bodies, implementing bodies operating conformity assessment programs as well as important "customers" of legal metrology. Existing Societies, some covering the whole field of metrology and not limited to legal metrology, seem to serve a useful purpose, establishing general awareness of the potential of legal metrology and the justification of meaningful conformity assessment programs. The establishment of a Society may be a way for many more CIML Members to extend or overcome shortcomings of relevant relations.

The identification of relevant legislation and implementing bodies, the establishment of National Legal Metrology Societies, perhaps as a subdivision of an existing National Metrology Society, and similar efforts to promote closer relation between bodies responsible for legal metrology at the national level, is encouraged by OIML, but is of course initiated and carried out at the national level.

What OIML can do is to address the task of guidance and promotion of closer relations by producing a guidance document in support of CIML Members facing administrative and similar problems of initiating relevant relations.

OIML should also revise its brochure, particularly focusing on promoting OIML as an efficient partner on the international scene to modern national legal metrology bodies, who may be unfamiliar with the concept of legal metrology, and largely unfamiliar with the efficient ways traditional legal metrology handles questions of compatibility, conformity and metrological coherence.

The publication must focus on the usefulness of OIML in handling international compatibility questions, and thus encourage participation in relevant technical OIML activities.

In conclusion

- ♦ *a supplement to the OIML brochure should be carried out, if necessary with professional assistance, focusing on fostering relevant inter-relations at the national level to encourage active participation in OIML endeavours in all modern fields of legal metrology*
- ♦ *a guide on the promotion of inter-departmental relation between national legal metrology bodies should be considered, and assistance should be provided as far as possible in such matters.*
- ♦ *to enhance and promote inter-departmental relations between national legal metrology bodies, support or establishment of National Societies of Legal Metrology should be considered and encouraged by CIML Members .*

VII.

Globalisation of trade

It is perfectly justified to say that the present trend of globalisation of trade is the strongest thrust boosting current interest in metrology and its rapid development.

It is also the most important challenge to legal metrology as far as trade agreements based on minimising obstacles to trade and mutual recognition agreements of equivalence of conformity assessment procedures are concerned.

Globalisation of trade is going to do to legal metrology what integrated production is going to do to industrial metrology.

The Enfield inch syndrome of industrial metrology

During the first world war some components of the Lee Enfield rifles were manufactured in Britain, others were produced under licence in the United States. The various parts were not assembled until they were delivered to the fighting front where it was discovered that they were incompatible. The problem was traced to the Enfield factory's gauge block standard being some 2,5 μm different from the Imperial inch, whereas the American factory had ensured at the start of the contract that its standards were accurate⁸⁾.

The Enfield inch has become synonymous with symptoms of local and short time consistency and reproducibility in metrology. Much has since been achieved towards reducing the damage. In industrial metrology the requirements of integrated production will put an end to it.

Just like the globalisation of trade will put end to incompatibility in legal metrology.

Awareness and alertness to this will decide the future of legal metrology. Legal metrology will either surf the tide of changes and further develop the tools to give confidence to measurement, or it will be swept away by the process of minimising non-compatible barriers to trade and be replaced by trade agreements with no obstacles of legal metrology.

Legal metrology is by its regulatory nature, particularly sensitive to the process of minimising obstacles to trade. Governmental and official regulations are without exception real and potential technical barriers to trade, unless regionally and ultimately internationally compatible. That is why national adoption of internationally recommended metrological requirements and compatible implementation programs of conformity assessment procedures, is fast becoming by far the most urgent and important challenge to legal metrology.

The non-compatible metrological requirements will go. Sooner or later. The process will take place concurring with the gradual implementation of trade agreements. Failing to meet this challenge successfully will in principle only have one possible outcome. Legal metrology goes. Or rather, legal metrology bodies will be relieved from implementing their responsibilities in all areas where non-compatible requirements remain as technical barriers and obstacles to trade; quite simply replaced by trade agreements.

It is imperative to appreciate that the globalisation of trade is not only a challenge to legal metrology. What it is about to require of legal metrology for the 21st century, presents

A. A threefold challenge to OIML.

The globalisation of trade has elevated the level and broadened the extent of demand for international compatibility of metrological requirements and of equivalence of conformity assessment procedures far beyond what previously used to be considered by OIML.

OIML is however *the* international organisation, charged by its treaty to promote international compatibility in the field of legal metrology, not a limited compatibility, but the full compatibility that society, government in partnership with the "market" if you like, of the Member States, at any time require.

1. *International compatibility of metrological regulations*

- ♦ The first challenge to OIML is the traditional one of determining the necessary and adequate metrological requirements to which measuring instruments must conform in order for them to be approved by Member States and for their use to be recommended internationally. As soon as Member States takes advantage of the OIML International Recommendations by adopting them as national requirements, they become the internationally compatible metrological regulations.

The minimising of technical barriers to trade requires compatibility of metrological requirements. Addressing this through the work of the Technical Committees, is currently given the highest priority in OIML. The long list of International Recommendations, most of them revised and updated, affecting a great variety of measuring instruments in all fields of traditional and modern legal metrology, show how successful this work is.

In the latest years however, as pressure from trade agreements for compatibility strongly increase, the output of new and important OIML International Recommendations has slightly decreased.

There are a couple of main reasons for this. OIML will have to address both.

1. The matters of "classical" legal metrology have already been dealt with. The areas of traditional legal metrology are well covered by International Recommendations,

elaborated by technical experts, largely drawn from the staff of the National Legal Metrology Institutes of the Member States.

The technical expertise of these Institutes is often limited to traditional legal metrology and as a consequence they may have difficulties supplying the necessary technical expertise for the elaboration of the International Recommendations that OIML need to cover the modern fields of legal metrology.

As long as the modern fields of legal metrology at the national level in many Member States is characterised by a lack of metrological co-ordination and inter-relation and a limited responsibility on the part of the National Legal Metrology Institutes, the shortcoming of contribution from the relevant technical expertise to maintain the necessary productivity of International Recommendations, will persist.

To break the deadlock, OIML, the international organisation for the full range of legal metrology, will have to address the problem by promoting closer relations between all national departments responsible for legal metrology wherever such problems prevail.

2. In Europe and the US efforts have been focused on elaborating regional regulations. This has drained resources who otherwise possibly might have been available to some extent for elaborating regulations to be recommended internationally. Not all of these regional regulations are necessarily fully compatible with those recommended by OIML and are unlikely to be generally accepted internationally. Their elaboration are counter-productive from the point of view of international compatibility, and serve to maintain regional technical barriers to trade. The international impact of these regional regulations should not be overestimated however, as they are generally focused on legal metrology in retail trade and represent technical barriers only to the trade of instruments.

A hopeful indication of a possible change is a recent unilateral European suggestion of assuming compatibility to European regulations of instruments in conformity with OIML International Recommendations.

In any case, any development of regional regulations, non-compatible with those internationally recommended by OIML, is detrimental to the efforts of achieving international compatibility, and will need to be closely followed and if necessary addressed.

Having said this it must be added that the current extensive regional co-operation in legal metrology by national legal metrology bodies are normally anything but for the purpose of establishing regulations. It focus on establishing compatibility and represent one of the most important and promising developments of co-operation in current legal metrology, underpinning and taking advantage of the international co-operation through OIML and should be strongly supported and promoted by OIML.

To enhance the efficiency of the relations between OIML and the Regional Legal Metrology Bodies (RLMO) and promote compatibility of conformity assessment, a Joint Committee of the RLMO's and OIML (JCRO) should be created and mandated.

The maintenance of productivity of OIML International Recommendations is not the only challenge, perhaps not even the most important, when it comes to promote international compatibility of metrological regulations.

The globalisation of trade, promoted by the World Trade Organisation (WTO), implies an increase of supra-national decisions as regards obstacles to trade, at the expense of the old national prerogative to take decisions.

This is a new and different situation to OIML. When the OIML treaty was conceived, the sovereign Member State elaborated whatever national legal metrology regulations it wanted. By signing the OIML treaty the Member States accepted a moral obligation to implement as far as possible the regulations recommended by OIML, as national regulations.

Globalisation of trade is gradually changing all that. In the foreseeable future the Member State may no longer be the only stakeholder to address. Supra-national bodies, such as bi- and multinational trade agreements, ultimately WTO, will decide which technical barriers to trade to minimise, including those that may be imposed by legal metrology regulations, and which compatible legal metrology regulations to be implemented by compatible operational conformity assessment procedures by all participants in the actual agreement.

In short, the Member State will maintain its prerogative to decide what to legislate and to what extent, the trade agreement will require compatibility of the implementation of the legislation and may want or have to decide on how to achieve this.

The relevant Article I.7 of the OIML treaty¹⁾ will have to be understood in view of the new situation. OIML will have to address not only the Member State, but also the new stakeholder, the trade agreement, for implementation as far as possible of the regulations recommended by OIML, as regulations in the region of the trade agreement. The purpose of this understanding is to ascertain that trade agreements takes full advantage of and gives full support to OIML as *the* international organisation charged with the objective of promoting international compatibility in the field of legal metrology by determining the necessary and adequate requirements for measuring instruments and the corresponding conformity assessment, for their use to be recommended internationally.

In conclusion

- ♦ *OIML should set up a Joint Committee (JCRO) to promote and entertain the relations between the Regional Legal Metrology Organisations and OIML..*
- ♦ *The current close liaison with WTO should be strongly supported and encouraged*
 - *with the objective of promoting international compatibility in the field of legal metrology by adoption of OIML International Recommendations.*

2. Compatibility of conformity assessment

- ♦ The second challenge concern the OIML activities in the field of achieving international compatibility of conformity assessment procedures. It is essential to realise that compatibility in legal metrology, in the sense of minimising obstacles to trade, not only affects the metrological requirements, the regulations, but also their implementation, the conformity assessment procedures.

Compatibility of conformity assessment is required as condition for mutual agreements of equivalence of conformity assessment, of compliance documentation, of certificates etc., all of which in support of trade agreements.

Non-equivalence of conformity assessment may lead to differing national decisions concerning conformity and measurement results and prevent mutual confidence, i.e. unnecessary obstacles to trade.

Only for verification in situ of instruments used in retail trade, there is no need for international compatibility of conformity assessment procedures. All other cases will need it, including instruments for pre-packaging for retail trade.

Trade of instruments and of products measured by conformity assessed instruments other than in retail trade, exchange and trade of information and decisions based on measurement in health, safety and environment, measured by conformity assessed and verified instruments, all involve cross-border, regional or international activities and will need compatibility.

OIML can not limit its activities to international compatibility of metrological requirements for measuring instruments. OIML must give priority to one step closer to the measurement result in which all users can have confidence.

For some time this has already been on the agenda of OIML, as all new and revised International Recommendations include the necessary and adequate procedures and equipment for conformity assessment.

Currently it needs prioritised attention and to be addressed with great determination. The fine tuning by the Technical Committees of methods and procedures for conformity assessment in their draft recommendations is the basic condition for achieving compatibility.

A number of further steps can realistically and efficiently be undertaken to promote compatibility of conformity assessment in accordance with OIML International Recommendations.

The checking of equivalence of reference standards, proficiency testing, promotion of accreditation, of special training, all of which is covered under separate entries in this report.

Compliance documentation (verification certificates etc.) will be in increasing demand for instruments subject to legal metrology control. It will complement stamping as confirmation of compliance, it will be required as documentation for quality system certification purposes, for trade agreements, and for transparency.

Legally valid confirmation of measurement result will increasingly become in demand in environmental control and pollution monitoring as well as in international trade, in particular for bulk measurement of minerals, oil, gas, agricultural products etc., especially when resource control or fiscal revenue is an element.

The Technical Committees should be requested to include formats for OIML compliance documentation and for OIML measurement result confirmation in all new and revised recommendations.

In conclusion

- ♦ *The Technical Committees should include formats for reporting conformity verification (verification certificates) and inspection (inspection certificates), in new and revised International Recommendations, to serve as OIML compliance documentation*
- ♦ *The Technical Committees should include formats for the confirmation of the measurement result in new and revised International Recommendations, to serve as OIML measurement result confirmation.*
- ♦ *The Joint Committee (JCRO) set up to promote and entertain the relations between the Regional Legal Metrology Organisations and OIML should be encouraged to promote programs of compatibility of conformity assessment.*

3. Agreements of mutual recognition of equivalence

- ♦ The third and most challenging part is arrangements/agreements of mutual recognition of equivalence of
 - operational conformity assessment procedures and of
 - conformity certificates issued by national legal metrology institutes or authorities, such as the OIML Certificate etc.

The whole exercise of establishing metrological regulations that can be recommended for international compatibility and of establishing the necessary and adequate procedures for internationally compatible conformity assessment, would be of limited consequence unless it is followed up with agreements of mutual recognition of equivalence of conformity assessment, certificates, etc.

The purpose is to open up possibilities for more rational and cost-efficient legal metrology services and to avoid obstacles to international trade and exchange of metrology based information by accepting the results of credible conformity assessment in other countries or regions, without unduly repeating the tests, i.e. accepting "one-stop tests".

This has been on the agenda of OIML for some time. The OIML Certificate System is part of these efforts. So is the inclusion of the format for reporting test results in International Recommendations. And a number of OIML International Documents offer relevant guidelines.

But it is no longer sufficient to leave the question of formalising agreements of mutual recognition of equivalence to guiding documents such as the International Document 13.

Other international organisations actively and directly promote various mutual recognition agreement in support of trade agreements. It is an activity that currently need to be addressed with more attention and dedication by OIML, facing the 21st century.

OIML will have to negotiate the challenge of promoting relevant and formalised agreements between national legal metrology bodies of the Member States, in conformity with similar initiatives that presently are taken by other international organisations with parallel objectives.

In conclusion

- ♦ *OIML should address the question of promoting formalisation of bi- or multinational agreements of mutual recognition of equivalence of*
 - *national legal metrology reference standards^{*)},*
 - *national legal metrology regulations and requirements,*
 - *national conformity assessment procedures,*
 - *certificates issued by national legal metrology bodies, i.e. OIML compliance documents.*
- ♦ *OIML should speed up the development of formalising a multinational recognition agreement on the OIML Certificate System*

^{*)} *reference standard* is a standard generally having the highest metrological quality available at a given location or in a given organization, from which measurements made there are derived ⁴⁾(6.6). A working standard is usually calibrated against a reference standard ⁴⁾(6.7.1).

VIII. Establishing mutual confidence in legal metrology

Mutual confidence is the inevitable condition for establishing recognition of equivalence, acceptance of conformity certificates, agreements on one-stop testing.

Mutual recognition is the desired consequence of confidence, it does not precede confidence, unless you are willing to take the chance of costly disappointments.

Legislation relevant to metrology is fundamental to legal metrology, the very *raison d'être* of legal metrology - without legislation there would simply not be any legal metrology. But legislation does not by itself establish confidence in the conformity assessing activities of legal metrology.

It is not possible to legislate confidence. As much as the need for confidence in measurement is the very justification for the legislation, confidence in the implementing bodies need to be acknowledged by impartial means.

The traditional stamp of confidence, is delegation or notification by the government.

A. Accreditation

To metrology, independent, third party expert assessment, i.e. accreditation, is the modern and rational tool to develop confidence. If one could achieve globally uniform, global equivalence of the implementation of relevant accreditation, which is the objective of ILAC, very many of the problems national legal metrology conformity assessing bodies are faced with en route towards mutual recognition of equivalence, would find a rational solution.

Accreditation is also a rational tool to enhance metrological coherence and promote national and international compatibility of conformity assessment. This is particularly the case for the great number of new conformity assessment bodies, private and public, in the modern fields of legal metrology, in human health and safety, in pollution and resource control and so on.

The objective of OIML is international compatibility of regulations and conformity assessment, and should continue to lead the way in these matters, but accreditation, provided it is globally uniformly implemented, is the current tool to achieve confidence in the relevant equivalence of the implementation that is actually carried out by legal metrology conformity assessing bodies.

Of relevance to accreditation in legal metrology are the jointly published ISO/IEC Guides for the assessment *of competence of laboratories and of laboratory accreditation systems*, in particular:

- ♦ ISO/IEC Guide 25. General requirements for the competence of calibration and testing laboratories (pending replacement by current draft IS 17025); and
- ♦ ISO/IEC Guide 58. Calibration and testing laboratory accreditation systems - General requirements for operation and recognition.

The ISO 9000 series of standards on product and company quality system certification has had a beneficial impact on metrology by alerting many organisations to their need for traceability.

In some cases however, confusion has unfortunately arisen between the roles of

- ♦ quality certification by the ISO 9000 series of standards on quality management and quality assurance, and

- ♦ laboratory accreditation by the ISO/IEC Guide 25, "General requirements for the competence of testing and calibration laboratories".

Certification in accordance with the ISO 9000 series is restricted to quality management and quality assurance and is not concerned with metrological competence in conformity assessment.

Accreditation by the ISO/IEC Guide 25 includes both the quality assurance bit and the requirements for the competence.

The technical term accreditation may not yet be familiar to everybody and is unfortunately neither unambiguous nor uniquely used for accreditation as understood by the ISO/IEC Guides 25 and 58. It would simplify matter if the metrology world would adopt the same understanding of the term as the ISO/IEC Guides.

Accreditation as used in this context, as understood by the ISO/IEC Guides:

- ♦ is the acknowledgement of *quality and specific capability and competence*,
- ♦ issued by an independent, "third party" accreditation body, *internationally recognised* as an accreditation body operating in accordance with ISO/IEC Guide 58,
- ♦ after a comprehensive assessment in accordance with ISO Guide 25 and all relevant application documents, conducted by the issuing "third party" accreditation body, assisted by appropriate technical expertise in accordance with ISO/IEC Guide 58.

Self-declaration of quality assurance and competence, is in some cases spoken for as an alternative to accreditation by a third party. Mostly motivated by economic reasons. However as much as a self-declaration may seem fully justified by the self-declaring party, it may not appear equally convincing to other parties. Unless the self-declaring party is already generally assumed to have an excellent level of metrology. Which shows that self-declaration is a discriminating alternative that does not leave much chance to new or small metrology institutes or to metrology in developing countries.

It is also a deceptive idea that self-declaration is less costly than accreditation by a third party. A self-declaration will eventually have to be validated by supporting documentation, the very documentation required for the accreditation process. Producing this documentation is where the bulk of the cost of accreditation lies. Making the difference in cost between a validated self-declaration and a third party accreditation questionable.

And who would want a non-validated self-declaration?

The self-declaration alternative is hardly cost-effective as it is not likely to produce the confidence, which is the very purpose.

Peer assessment of legal metrology conformity assessing laboratories and agents in stead of accreditation of the same is also occasionally spoken for, maintaining that it is "more practical and less costly". At a very limited scale it might appear so. But the globalisation of trade requires the systematic development of multinational agreements of equivalence. Which means that everybody will need to peer assess everybody else, and the cost will become prohibitive. The drain of metrological manpower likewise.

And peer assessment totally miss the crucial point. To have any value, the assessment must be the same, uniformly applied, equivalent, everywhere, globally, for all assessed, by all assessors. By its very nature, peer assessment can not deliver.

That can only realistically be achieved by uniformly applying the ISO/IEC Guides 25 and 58 globally by a network of specialised, professional, independent, internationally recognised national accreditation bodies.

Only then it will be possible to have the confidence to accept without reservation as equivalent the "one-stop test" conformity certificates issued by any private or public legal metrology body, which is accredited for the particular conformity test or verification, regardless of whether it is a "weights and measures" body or deals with medical or safety instruments or the instruments used in pollution or resource monitoring, regardless of whether it is a body from your own country, own region or from another part of the world. And that is exactly what the globalisation of trade is heading for fast. That is what will arrive to you by stealth.

To be or not to be accredited is however up to the discretion of every single legal metrology body, that decision is not up to OIML.

OIML is concerned with promoting international compatibility. The objectives of OIML are "to study, with a view to unification of methods and regulations, the problems of legal metrology, of legislative and regulatory character, the solution of which is of international interest"¹⁾.

In this case it can mean only one thing.

OIML must urgently take a strong lead, in close co-operation with ILAC, to establish fully internationally compatible application documents, the guidelines for establishing specific requirements for legal metrology laboratory competence, for the ISO/IEC Guide 25 to be globally uniformly applied to the full range of different modern and traditional legal metrology activities, in trade, human health and safety, pollution and resource control and so on.

An indication of the urgency is that CIPM and ILAC have already been working on the application of ISO/IEC Guide 25 to national metrology institutes for some time, and developed some draft guidelines.

The locomotive of accreditation has currently such a momentum, is moving so fast, that there is no time to loose. Legal metrology can not afford the application of the ISO/IEC Guide 25 to legal metrology, the specific requirements for legal metrology laboratory competence, to be decided by somebody without the expertise of legal metrology.

It is a clear responsibility imposed by it's treaty, for OIML to address this question.

In conclusion

- ♦ *The OIML Working Group on Accreditation in Legal Metrology should urgently take a strong lead, in close co-operation with ILAC, to create guidelines for establishing appropriately specific requirements for the competence of different legal metrology bodies operating conformity assessment procedures in trade, human health and safety, environmental and resource control and so on, to enable the ISO/IEC Guide 25 to be globally uniformly applied in the field of legal metrology.*

B. Measurement uncertainty

One example of the need for OIML urgently to take a strong lead in the elaboration of guidelines for establishing specific requirements for legal metrology laboratory competence, is the special treatment of measurement uncertainty in verification, as opposed to the treatment of uncertainty in calibration.

The working standard used to verify an instrument, i.e. to confirm i.a. that the instrument is operating within mandatory maximum permissible errors, is itself also either verified, i.e. satisfies mandatory maximum permissible errors or it is calibrated, i.e. its error as compared to a reference standard is known. To answer elementary requirements for consistency and transparency, legal metrology will be challenged as to what that it really means that an instrument is confirmed to be within mandatory maximum permissible errors.

Is the verified instrument operating inside the mandatory maximum permissible errors of its own plus that of the working standard, is the maximum permissible error of the working standard included, or what is it, really, in each Member State?

The question may not seem too important for legal metrology dealing exclusively with retail trade, with the exception of pre-packages, but for all legal metrology beyond that and particularly for the modern areas of legal metrology, the consistency, transparency and perhaps even credibility will depend on a satisfying answer to the question.

It will be up to OIML to address the problem. The principal question of applying uncertainty to the maximum permissible error and how to apply it, will first have to be decided. Then each Technical Committee will have to establish the proper uncertainty budgets relevant to the verifications covered by each International Recommendation.

In conclusion

- ♦ *The principle of applying uncertainty to the maximum permissible error and how to apply it should be adopted.*
- ♦ *The Technical Committees should include in the draft Recommendations, the appropriate uncertainty to be applied to the maximum permissible error of the instrument in question and of the working standards used for conformity verification.*

C. Equivalence of the reference standards of legal metrology.

Equivalence of national measurement standards is a fundamental prerequisite for the global measurement system and is one of the basic objectives of the Convention du Mètre.

Before entering into major governmental bi- and multilateral trade agreements, nations are today insisting on the equivalence of national measurement standards. This is a policy supported by the World Trade Organisation.

In response to these demands, BIPM has upgraded its efforts to establish the degree of equivalence of national measurement standards related to the SI by implementing an extensive program of key comparisons designed to promote mutual recognition of national measurement standards and calibration certificates issued by national metrology institutes.

The success of this program is of vital importance for the full realisation of the global measurement system and for establishing bi- and multilateral trade agreements.

Key comparisons will necessarily be limited in numbers, and will most efficiently affect the equivalence of legal metrology reference standards as intended when the traceability chains are simple and well defined. Equivalence of reference standards depend on an operational and metrologically valid dissemination of the equivalence of the national standards. This must be delivered, often by a complicated infrastructure of vertical, diagonal and occasionally

horizontal traceability, frequently through chains of primary and transfer standards for derived quantities, for multiples and submultiples.

The quality and extent to which such disseminating infrastructures are operational at the national level, varies widely. Particularly new areas of legal metrology suffer shortcomings.

Shortcomings are however not limited to new areas of legal metrology. There are some infamous, past and current cases of important intergovernmental trade disputes between highly industrialised countries, involving very considerable amount of revenue. The disputes are resulting from non-equivalence of the standards and methods used for conformity verification of instruments used for cross-country trade. In these cases the equivalence of the respective national standards was indisputable. The infrastructure of disseminating the equivalence, the chains of traceability, had failed to deliver the desired results.

Current and upcoming disputes will continue to reveal unacceptable non-equivalence of reference and working standards, no matter how equivalent the national standards are shown to be by extensive programs of key comparisons. This is particularly likely to happen in the modern areas of legal metrology, such as pollution monitoring.

In turn this will question the role and justification of legal metrology and the way it carries out its business, particularly when it comes to its services related to international trade and its role of underpinning trade agreements.

Is there a need for bi- and multilateral trade agreements to require equivalence of the reference standards of legal metrology as a condition for accepting OIML compliance documentation, i.e. certificates, in general and specially for one-stop tests?

Since key comparisons is limited to cover a range of standards so as to test the principal techniques in the field of each of the Consultative Committees; since the equivalence of national standards confirmed by key comparisons not by itself also establish equivalence of the reference standards of legal metrology, without regard to available, operational traceability, the answer is yes.

To monitor traceability is for practical reasons not realistic, but the answer to both operational traceability and the calibration skill that has gone into the traceability chain is the reference standard which in principle is available for comparisons. In practice, it is available at least to a limited extent, for comparisons.

It is a matter of course that the degree of equivalence of reference standards is important for the credibility of "one-stop testing". And for OIML compliance documents.

Documented knowledge about the degree of equivalence of legal metrology reference standards based on a certain level of activity of comparisons is no doubt going to be in growing demand to underpin claims of equivalence.

OIML will have to address this matter in accordance with the working methods of the organisation. Which means to request relevant specifications from the Technical Committees and to encourage the Regional Legal Metrology Organisations (RLMO) to run comparisons of the reference standards of their participants and to establish their degree of equivalence. Reference standards for derived quantities and such with cross-border or otherwise complicated traceability chains should be given priority.

When elaborating the various draft recommendations, the Technical Committees is detailing methods and equipment for conformity assessment. This will necessarily have to be based on detailed knowledge of the appropriate reference standards and traceability chains required. The Technical Committees should be requested to include in the listing of equipment in new and revised drafts, a specific section specifying the appropriate reference standards and traceability chains required for conformity verification of the instruments covered by the draft.

The Joint Committee entertaining the relations between OIML and the Regional Legal Metrology Bodies, should encourage carefully selected programs of comparisons of national legal metrology reference standards, based on the relevant listed specifications of the various International Recommendations, to be carried out by the members of the regional legal metrology bodies. The comparisons should be known as "OIML comparisons".

BIML should be asked to supply co-ordination and to publish the results of OIML comparisons in the Bulletin.

In conclusion

- ♦ *The Technical Committees should include a specific section for appropriate reference standards and traceability chains in the listing of equipment for testing and verifying conformity, in all new drafts and revised International Recommendations,*
- ♦ *Programs of OIML comparisons (reference standards) based on the relevant specifications of the various International Recommendations and carefully selected by the JCRO, should be encouraged to be implemented by the regional legal metrology bodies.*
- ♦ *The results of OIML comparisons should be published in the OIML Bulletin.*

D. Proficiency testing

There is however an additional question relating to the establishment of confidence between Member States and particularly relating to international compatibility of the implementation of the methods for testing and verifying conformity to the requirements of the International Recommendations, that OIML should address with vigour,

This question is generally known as proficiency testing.

It is conducted by circulating instruments covered by the International Recommendations to a number of legal metrology bodies, preferably in different countries, either for pattern approval proficiency testing or for verification proficiency testing, followed by analysis and reporting.

The ways open for OIML to address this important side of the international equivalence of methods are:

- 1 to request the Technical Committees to include in the description of methods and equipment for testing and verifying conformity to the Recommendation, a specification of instruments or types of instruments particularly suitable for International Recommendation-relevant proficiency testing that shall be known as "instruments suitable for OIML IR-proficiency testing"..
- 2 to encourage the regional legal metrology organisation to run proficiency testing on a limited number of very carefully selected "instruments suitable for OIML IR-proficiency testing".

- 3 to publish the results of such proficiency testing in the OIML Bulletin, to promote confidence and equivalence of methods.

In conclusion

- ♦ *The Technical Committees should include in the draft Recommendations, a list of specific instruments suitable for OIML IR-proficiency testing.*
- ♦ *The regional legal metrology bodies should be encouraged to run programs of OIML IR-proficiency testing, carefully selected by the JCRO.*
- ♦ *The results of OIML IR-proficiency testing should be published in the OIML Bulletin*

E. Traceability in general

Per definition, VIM⁴⁾ 6.10, traceability is the "Property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties".

Most readers of this draft are familiar with the concept of traceability.

Traceability is fundamental to the dissemination of the SI and the realisation of the global measurement system. It is a firm and uncompromising requirement and condition for accreditation. To a certain degree traceability is formally required for ISO 9000 certification. It is usually a statutory requirement for working standards, as a provision of the Law in the field of classical legal metrology.

But to what extent does traceability, in the strict sense of the definition, actually penetrate the world of metrology?

It is estimated that between 10% and 20% of all calibration and testing laboratories presently are accredited. Of course the percentage varies from one field of measurement to another, it depends on how well the accreditation service in the particular country or area is established and how long it has been working. Assuming that these accredited laboratories carries out about 20% of all calibration and testing, may be a little more, may be a little less. That leaves about 80% of all calibration and testing to be carried out by not accredited laboratories.

Particularly in the field of modern legal metrology the level of accreditation is low and the amount of non accredited calibration, conformity assessment and testing might well be above 80%. In how many countries would you expect to find the dosimeters used in radiotherapy with traceable conformity assessment, or portable gas chromatographs?

How many of the accredited laboratories had their traceability in shipshape before they started their accreditation procedure? Not very many.

Bear in mind that it is often the best equipped and most competent laboratories that first applies for accreditation.

It is reason to believe that towards 80% of all calibration and testing that is carried out today is not traceable in the strict sense of the concept.

That does not mean that the 80% are all wrong. Not all areas of metrology need traceability. Where short term consistency and local reproducibility is all that is objectively required, traceability may not be required. In large areas of metrology, such as some areas of metrology in chemistry, traceability is still not available for technical reasons.

In many cases the traceability chain need not reach every measurement instrument. Like the tape manufacturer, who has his master tape, the one he uses for production control, occasionally calibrated by an accredited laboratory.

Common for the 80% is however that regardless of whether they actually need traceability or not, neither calibration, testing nor conformity assessment will enjoy the level of confidence traceability gives.

It is reason to believe that full penetration of traceability is largely limited to the areas where industry feel the strongest pressure of competition, to metrology for military purposes, and to where it is explicitly required by legislation, i.e. largely to the traditional legal metrology.

In conclusion

- ♦ *To raise the level of confidence and to extend the actual use of the global measurement system, it is reason to wish for more extensive use of legislative requirements for traceability in conformity assessment. Requirements for traceability should be addressed when revising the OIML Document 1.*

IX. Key comparisons and legal metrology

Key comparisons, as defined by the "Mutual recognition agreement for national measurement standards and calibration certificates issued by national metrology institutes"⁹⁾, is initiated by BIPM to establish the degree of equivalence of the national measurements standards.

Key comparisons are not an end in itself, not even the equivalence of national standards. The intended purpose is to support multilateral agreements to accept calibration and test certificates issued by accredited laboratories. It is further expected that it will "open the way and provide the technical basis for wider agreements related to trade and commerce"⁹⁾.

Legal metrology is dependent on equivalence of national measurement standards to enable compatibility of conformity assessment in support of trade agreements and mutual recognition of equivalence of legal metrology certificates and OIML compliance documents.

As the bodies of the Convention du Mètre offers an extended program of key comparisons to provide the technical basis for agreements related to trade and commerce, it becomes a responsibility for legal metrology to follow up by providing relevant dissemination.

Pending CIML decision, it will be a high priority responsibility of the OIML Technical Committees, particularly the topic-oriented, to ensure that full advantage is taken of the equivalence established by the key comparison programs by instigating the dissemination of such equivalence down to the working standards of legal metrology, through relevant traceability chains. This will require comprehensive interaction between the Technical Committees and the national legal metrology bodies concerned.

These activities will constitute a very sensitive gauge in the regulated area of the technical results of key comparisons, of how well the selected programs of key comparison satisfy the wider intentions of providing a technical basis for agreements related to trade and commerce and likewise of current needs waiting to be covered by key comparisons.

Key comparisons may well succeed in creating the intended equivalence as well as acceptance of calibration and test certificates issued by accredited laboratories, but fail it's underlying *raison d'être* of providing the technical basis for wider agreements related to trade and commerce if missing any important area where trade can be shown to need equivalence at key comparison level.

In this way the selection of key comparison programs is important to legal metrology as "customer" and end user of the disseminated results in comprehensive metrological conformity assessment activities, particularly those related to trade and commerce.

To take a simple example. Sonic nozzles are instruments for the measurement of fluid flow. Trade agreements require enormous quantities of fluid to be measured cross-border and cross-regional every day. Even the ordinarily accepted daily measurement uncertainty amounts to fortunes. In many countries all over the world these measurements are under legal metrology control, often for fiscal reasons. Conformity verification of sonic nozzles is technically complicated, so are the corresponding traceability chains. Relevant key comparisons to cover this and similar fields may not necessarily be very interesting from the state of art of national standards point of view, but it certainly is for providing the technical basis for agreements related to trade and commerce.

The key comparisons are selected by the Consultative Committees. In each field of the respective Consultative Committee a set of key comparisons is identified which covers a range of standards so as to test the principal techniques in the field. For very obvious reasons of where to find the relevant metrological expertise, the selection procedure is a closed system between the Consultative Committees and the national metrology institutes (ref. Appendix E to the agreement, article 3).

There is no formal way provided by the agreement for legal metrology, or for that matter for anybody else concerned, to provide information about important areas where trade and commerce possibly can be shown to need equivalence at key comparison level.

Key comparisons will necessarily have to be limited in number and if the selecting Consultative Committee has to prioritise, they might want external information as to how the established equivalence penetrates to trade agreements and which areas of metrology need to underpin trade and commerce at the level of key comparisons.

OIML might be in a position to supply relevant information. Such as feedback from the interaction between the Technical Committees and the national legal metrology bodies about the technical results, including availability of relevant traceability chains to enable appropriate dissemination in the regulated area relating to trade agreements. And about needs to be covered.

All that remains is for BIML to organise the collection of this information at regular intervals and for OIML to pass it on in an appropriate and agreed way. The latter might be through the forum of co-operation between BIPM, ILAC and OIML.

In conclusion

- ♦ *The OIML Technical Committees takes on a responsibility of promoting and instigating the dissemination of equivalence established by key comparisons and to register areas in need of support at the level of key comparisons*
- ♦ *BIML initiates and collects information about this activity at regular intervals*
- ♦ *OIML should seek to use the forum of the co-operation between BIPM, ILAC and OIML to convey relevant information in support of the key comparisons and as regards any particular needs known to legal metrology at the level of key comparisons*

X.

Training

Training in the legal metrology field is traditionally a fundstarved activity.

It is estimated that in traditional legal metrology more than a hundred thousand people are working on a global basis. But they are thinly spread, much depending on the development of infrastructure in different countries. This explains that the traditional national approach is "on the job" training of people with a technical background and that only well developed and populous nations can offer relevant professional training on a regular basis.

When the yearly recruitment of new appointments to the national legal metrology service is below a certain level, it is often too costly and not rational to run "classroom" type of training. Then "on the job" training has proven to be a slow but very good alternative. That is, as long as legal metrology is static, as long as there is little development of legal metrology. Learning from "the elders" is notoriously conservative and can make it difficult to pick up new technology. It has worked however, successfully, for ages, all over the world.

But that is now coming to an end. *"The old era is ending. The old ways will not do"¹²⁾*.

The "on the job" training has one particular quality that makes it unsuitable today, it fosters non-conformity, it develops and promotes particular and local ways of doing things. Such as conformity assessment. This may not be intended, but it is an intrinsic characteristic the "on the job" training never can escape.

Today we need appropriate training to enable internationally equivalent implementation of compatible conformity assessment procedures. We need appropriate training to underpin multilateral agreements of equivalence. And for that, the old ways of "on the job" training will not do.

OIML's contribution in this field is well known to most of the readers. All the way from initiating, arranging or participating in seminars, workshops and conferences, to the many publications in the field, ranging from the special D 14 "Training of legal metrology personnel" and P 2 "Metrology training - Synthesis and bibliography" to a number of relevant International Documents and Other Publications.

Some countries run technical colleges, supporting their national need and offer opportunities for external scholarships.

Even if external participation is based on the "train the trainer" principle, it can never be more than a drop in the ocean for a profession that need to train more that 5-6000 new people every year and a yearly up-grading of more that a hundred thousand people on a global basis.

Considering the rapid technological, quantitative and organisational development of legal metrology, more training is more needed that ever. And the key word is, for better or for worse, *globally uniform training*.

It is therefore timely, perhaps urgent, for OIML to address the question of how a modern pedagogical approach to training, applying modern technology, hardware and software and the electronic communication technology of tomorrow, can respond to the challenge of globally uniform training of a very large quantity of technical "students".

To look into how a modern pedagogical approach to training, applying modern technology may overcome language and technical problems and efficiently replace the traditional

national approach to training and make relevant, internationally compatible, professional training and retraining easily and affordably available.

This is not a unique problem for legal metrology or for OIML. There is certainly already a number of answers and solutions that may be applied to the needs of legal metrology, directly or with relevant adjustment. Wasting time and resources by reinventing the wheel should be avoided.

What is it we actually, really need. Today, with legal metrology dominated by the globalisation of trade, development towards agreements of equivalence, one-stop testing, we need globally uniform training in conformity assessment in accordance with the OIML International Recommendations. That's all there is to it.

The role and responsibility of OIML is no longer restricted to produce the documentary metrological regulations that can be internationally recommended to enable compatibility, to enable the level of uniformity needed for agreements of equivalence of conformity assessment procedures. It also becomes an equally essential OIML responsibility to produce the pedagogical demonstration of how to operate the relevant conformity assessment procedures

How can OIML's role of promoting international compatibility be practised with this objective. It is really quite simple. Every new or revised International Recommendation contain the methods for testing and verifying conformity to that particular Recommendation. The experts of the Technical Committee have already carefully tested and selected the methods to be globally applied.

The training we need is restricted to the International Recommendations that actually exist at any time, the future will not be filled with agreements of equivalence to non-existing regulations.

To disseminate the knowledge, to train people in the methods by reading the International Recommendations is however hardly the pedagogically preferred solution. The methods have to be transferred to a media that can make the conformity assessment methods visual and easily available everywhere, globally.

One such medium is video. Video-machines and TV-sets are currently virtually available to everyone in legal metrology, everywhere.

The Technical Committees have all the expertise required concerning the methods. There are plenty of professional private companies specialising in video production for training purposes. The combination of these talents is all we need. And that will be the responsibility of OIML for compatibility of legal metrology training; to promote the video filming of the methods, to co-ordinate the technical experts of the Technical Committees and the video teams, to make sure the conformity assessment procedures specified by every International Recommendation are video-taped for training.

Not forgetting the distribution of the training videos. This is an OIML responsibility on par with maintaining availability and distribution of the International Recommendations. In the future each International Recommendation should contain a video training course in the methods for assessing conformity to the International Recommendation, including of course the calibration of the applicable reference standards and verification of the relevant working standards.

Each Member State or the Corresponding Member has to translate the International Recommendations to their official language(s). It will hardly be noticeable the extra job for the Member State or Corresponding Member to translate the video, to make subtitles or to dub it.

The cost? Well, this is certainly the most cost-efficient training the national legal metrology services can hope to enjoy. In principle they should be expected to pay for the videos. In practice it may become a nominal contribution. Unless it turns out to be a commercial success, which cannot be totally ruled out. After all, if there are more than a hundred thousand legal metrologists around the world, there must be some tens of thousands of local head quarters of legal metrology, all of them needing access to this particular training on a continual basis. Every one of the OIML training videos.

Perhaps it need a financial kick-off. Why not try UNESCO for sponsorship, one more time? Or private sponsorship? The video filming of the application of the methods will have to be done where the Technical Committee expertise and the testing and verification equipment is available. Some of the large metrology institutes might be interested in the publicity and offer sponsorship.

Computer based, interactive training and Internet as the modern solution to training, has many spokesmen. However well generally adapted to technical training, to legal metrology it may be a somewhat premature solution. The key word to training is availability. Neither Internet nor computers are extensively available at all levels of legal metrology activity in all Member States to satisfy the need for globally uniform training. Not yet. Whereas the video paraphernalia is.

And training that is convenient, cheap and available - will be used!

In conclusion

- ♦ *Each new or revised OIML International Recommendation should be attached the corresponding OIML training video*
- ♦ *Each Technical Committee should make their expertise concerning the methods for assessing and verifying conformity available for the shooting of OIML training videos*
- ♦ *Professional companies specialising in video production for training purposes should be engaged to produce OIML training videos*
- ♦ *sponsorship should be sought for the production of OIML training videos.*

XI. *Economic impact of infrastructural changes*

That the global measurement system has economic benefits is taken for granted. By metrologists.

Is it equally evident to everybody else that it is an essential value adding tool for commercial, technological and societal progress in the 21st century?

We need metrology infrastructures to make the global measurement system available for everybody. Metrology infrastructures needs funding. If we want to convince governments and policy makers to establish or modernising legal metrology infrastructures we need to communicate the economic benefits convincingly.

That does not come easy. It is notoriously difficult to present, justify and convince the decision makers about the need of metrology. The metrologist knows the language of metrology,

the decision maker that of profit and budget cuts. Allow me the metaphor of an old Arab saying *"The camel driver has his thoughts; the camel, he has his."*

Does the literature on the economics of metrology, actually relatively sparse, give any answers? It generally show a consensus on the economic rationale of metrology, but little is focused on infrastructure, and the convincing effect is at best questionable.

It is shown (by Link, 1992; Anderssen & McEvoy, 1991; NIST, 1993; Grindley, 1990; Fisher 1993) that metrology lower the cost of transactions, i.e. add value, by simplifying the process of communicating information about a product. Some focus on added value by reducing the level of conflict and litigation. On infrastructure Anderssen & McEvoy, (1991) and Drath, (1988), concluded that the economic benefits of metrology, though large, is unquantifiable. Convincing?

Some of the most widely publicised and best known studies may be questioned. DonVito¹⁰⁾ (1984) aimed to measure the added value contribution to GNP from measurement related activity in the US. Based on the labour ratio as a measure of the proportion of GNP affected by measurement, he concluded that the value added from measurement was 3,5% of GNP. This generally well known result has tended to be used rather uncritically by metrologists. It is questionable if the labour ratio can be used to measure value added. Using this method, improvements in efficiency leading to cost reductions would show a reduction in the added value. Convincing?

We want to know the economic importance of metrology infrastructure. To get such knowledge we have to study changes of metrology infrastructure, case by case. Causes and consequences.

We have to focus on changes of infrastructure and not on infrastructure itself because an economic impact must, by definition, cause economic agents to do something differently. Change is the key word and in this way only we will be able to produce results with convincing power.

What metrology is missing is well documented consequential analyses and publicised case studies on the economic impact of changes in metrology infrastructure.

And of the economic impact of changes in metrology related training.

Metrology is presently undergoing comprehensive infrastructural changes. The consequences should be studied and knowledge should be drawn from the experiences. Actual "live" examples have an added convincing value. Cost/benefit analysis of introduction respectively removal of infrastructure should be done as before/after exercises. Consequential analyses in the field of pollution monitoring based on changes of infrastructural strength, with bearings on reduction of international disputes or on the trade of CO₂ quotas, is only one of many obvious exercises that should be undertaken. Consequential analyses of the economic, societal and fiscal, impact of creating the infrastructure enabling a developing country to measure the export of its minerals by belt weighers (OIML R50), rather than by the draught of the cargo ship.

The overruling consideration by doing such studies must however be that the results are convincing to policy makers, decision makers, bridging the gap of communication between metrologists and decision makers.

Anything else is futile and pointless. Metrologists are already convinced.

To avoid criticism of bias and consequently loss of convincing power, the studies should not be conducted by metrologists.

The global measurement system and the promotion of international compatibility is inextricably linked to both national and international operational infrastructure of metrology. This fact is not well enough appreciated neither in the industrialised part of the world nor in the developing countries.

Only the large international companies know the practical importance of metrology infrastructure, both small and medium enterprises as well as governments need to be convinced about the necessity to create and use the infrastructure of the global measurement system as an essential tool for commercial, technical and societal progress in the 21st century.

To this end it is easy to appreciate that it is part of the current responsibilities of OIML to seek sponsors for studies of the economic impact of changes of metrology infrastructure and to publish the results.

It is generally known that the World Bank and other financial institutes and donors dealing with regional development matters, are backing efforts to enhance metrology. Many scattered attempts have been made, many with disappointing results. It is important to help both developing countries and donors to understand that to establish efficient metrology they have to establish infrastructure, rather than the bits and pieces and "projects" that are offered by donors. It might just be that donors at large, interested in improving the results of their efforts, might want to sponsor studies on economic impact of changes of metrology infrastructure.

In conclusion

- ♦ *sponsorship should be sought for studies of the economic impact of changes of metrology infrastructures.*

XII. International co-operation

The current international co-operation in metrology is a many-sided and complex activity. The current co-operation between the three "pillars" of the international infrastructure of metrology, BIPM, OIML and ILAC is fundamental.

What are the results we want from the endeavours of international co-operation? Are all of them getting satisfaction by internal co-operation between metrology organisations? Some are of course, and it should remain a priority of the OIML strategy, short as well as long term, to strongly promote it.

Still, some of the most important questions concerning metrology are not even touched by the internal co-operation between metrology organisations.

To actually be able to make the global measurement system an essential tool for commercial, technical and societal progress in the 21st century, it is essential to involve in an active co-operation, the important decision and policy makers, the ultimate users and beneficiaries of the global measurement system, such as the World Trade Organisation, the World Health Organisation, the World Bank, the most important regional Developing Banks, and so on.

It is imperative for the future of metrology that we entertain strong and vital external relation to the society we intend to serve, and not restrict ourselves to internal affairs.

We need to open up meaningful forums of co-operation with our users, and we are not likely to do that if we never confront the external world, if we restrict ourselves to internal communication.

How do we establish that kind of co-operation focused on external relations?

It can be done, by concerted targeting by BIPM, OIML and ILAC, gradually extended by dedicated targeting to several co-operating partners.

The practicalities of concerted targeting would be that OIML, BIPM and ILAC jointly appoint a small ad hoc working group for the policy and strategy for targeted external co-operation. The objectives of the working group:

- 1 to select a target
- 2 to decide on the objective of the intended co-operation between the target and OIML/BIPM/ILAC
- 3 to decide on a program of co-operation, carefully designed to meet the objective
- 4 and only then, when the objectives and the strategy is finalised and fully agreed, decide on the difficult and delicate task of how to successfully approach the target, and finally,
- 5 initiate the planned co-operation.

As an example, WTO may be looked on as a target.

Why concerted targeting of WTO? WTO promote the minimising of obstacles to trade by encouraging international harmonisation of technical (metrological performance) regulations (Art. 2.6.)¹¹⁾ and of conformity assessment procedures (Art. 5.5.)¹¹⁾, all of which is the proper objective of OIML.

Because it is important for the cost-efficiency, the confidence and transparency of the minimisation of such barriers to trade that it also involves corresponding and underpinning efforts to establish equivalence of national standards, calibration certificates and of laboratory accreditation. For cost-efficiency the whole infrastructure of the global measurement system should be collectively involved, not as separate un-related slices of infrastructure. It is a clear-cut example of "metrology is one of the few fields where a high degree of co-ordination is a rational and cost effective thing."⁷⁾

In a concerted co-operation with WTO, metrological realities and relevant priorities and strategies could be mutually communicated. To the concerted BIPM, OIML and ILAC, WTO is a "customer", a user of the global measurement system, to WTO the global measurement system represented by the concerted BIPM, OIML and ILAC, is a tool.

Harmonising metrological performance regulations and conformity assessment need to be underpinned by the full infrastructure of metrology and is after all quite different from minimising technical barriers to trade of toys.

In conclusion

- ♦ *The current internal co-operation between BIPM, ILAC and OIML should be strongly supported and encouraged*
- ♦ *targeted co-operation between on one hand OIML, BIPM and ILAC and on the other hand, carefully selected external partners, representing the ultimate users of metrology and the global metrology system, should be strongly supported and encouraged.*

XIII.

Annex I

A. The WTO Agreement and the main current conformity assessment procedures in legal metrology

1. Type approval.

In legal metrology a type approval is a decision taken by a competent authority designated by the State, recognising that a new model or type of instrument is in full conformity with the national mandatory type approval performance requirements for this category of instrument.

The purpose of type approval is to ensure that a new model or type of instrument is fit for its intended use, does not facilitate fraudulent or deceptive practices and will, in normal use, maintain its required metrological characteristics such as appropriate accuracy of measurement, for a reasonable time.

Type approval is a national responsibility. Countries who fail to legislate type approval as a mandatory requirement are prone for the dumping of instruments of qualities that can not be marketed elsewhere.

The OIML International Recommendations have two main purposes. One is to establish the relevant type approval and "in use" performance requirements. The other is to create the corresponding conformity assessment procedures. The present series of OIML International Recommendations cover a vast range of instrument categories, notably in the field of trade.

OIML Member States are morally obliged to implement them as far as possible. Under the WTO Agreement the WTO Members shall use them as basis for their technical regulations and shall also play a full part in the preparation of future OIML International Recommendations for instruments for which they have adopted or expect to adopt technical regulations.

From a technical and metrological point of view the type approval performance requirements are all the same for a given category of instruments, regardless of country. However, provided they do not create unnecessary obstacles to international trade, national supplementary requirements are allowed under the WTO Agreement, subject to justification and notification. Fundamental climatic or geographical factors (gravity) influencing accuracy or metrological consistency of instruments are recognised as justification for supplementary national requirements.

The decision of type approval is taken on the strength of the results of comprehensive conformity assessment procedures.

The type approval conformity assessment may be executed by specialised legal metrology laboratories, governmental or by delegation, private, or at the point of production by quality certification, accreditation of manufacturers test facilities and auditing of production models by the national legal metrology authority.

For all categories of instruments covered by OIML International Recommendations, the results of one credible and complete conformity assessment is sufficient, under the WTO Agreement, as basis for the decision of national type approval in all WTO Member States, completed only with the results of assessment of conformity to any supplementary national requirements, if applicable.

For simplicity this is known as "one stop test".

To this end OIML has developed the OIML Certificate System. A manufacturer may apply for an OIML Certificate to be issued in confirmation of one successful, complete conformity assessment, provided the results show full conformity to the OIML International Recommendation in question.

As a rational and cost-efficient way of eliminating unnecessary obstacles to trade under the WTO Agreement, Member States are encouraged to take advantage of the OIML Certificate as basis for their national decision of type approval, if applicable supported without creating unnecessary obstacles to trade, with reasonable spot checks and justified supplementary checks admitted by the WTO agreement.

Even if the OIML Certificate System is gradually proving its potential as the cost-efficient way of enabling national type approvals, the current situation is largely that national testing for type approval still remain as a metrological dinosaur.

Even if anything is redundant that goes beyond the reasonable spot checks and the supplementary checks admitted by the WTO agreement, the regulations of many countries still demand national testing for national type approval, repeating the same tests, largely arriving at the same results, over and over again, multiplying cost and time consumption of type approval, creating unnecessary obstacles to international trade, in violation of the WTO Agreement that require acceptance of results of credible and relevant conformity assessment procedures in other Members.

It may sometimes seem as if nation-based law-enforcement agencies are waging a 19th century war against the 21st century development.

Type approval and modern information and communication technology.

At the level of legal metrology laboratories computers, Internet and modern information technology is currently part of the daily work situation.

This should be taken advantage of by the instrument manufacturers who could contribute significantly to reduce the time and cost of type approvals and underpin the OIML Certificate System by making the most out of modern information and communication technology, using computers and Internet extensively to demonstrate and validate conformity to the type approval requirements of OIML International Recommendations of identified types of instruments.

To national legal metrology institutes without laboratory facilities such information will serve a need for transparency and maintain the capability for supplying the verifying officers with necessary information.

It will also contribute to support confidence where manufacturers are delegated the task of doing their own conformity assessment for type approval and/or initial verification.

2. Verification

Verification is done by the competent legal metrology authority to assess the individual type approved instrument as to conformity to all mandatory requirements, including appropriate accuracy, required to be satisfied under normal conditions of use in situ.

Initial verification is done before the instrument is put to use, later the instrument is reverified after repair and at regular intervals during its useful lifetime.

In some cases, for instruments or modules of instruments that can be transported without changing metrological characteristics, initial verification may be done before installation at

the point of use, in a laboratory or by delegation at the point of production, conditioned by quality certification, accreditation of manufacturers test facilities and auditing of production models by the national legal metrology authority.

If this is the case and the instrument is exported to be installed in another WTO Member Country, the WTO requirement that one credible and complete initial verification is sufficient, is valid. It is the "one-stop test", intended to minimise obstacles to trade.

Reverifications and other initial verifications are always done at the point of use of the instrument, and is irrelevant as for the WTO Agreement of minimising technical barriers to the trade of measuring instruments.

However, except for instruments exclusively used for retail trade, other instruments are or may be used for cross-border trade of commodities or exchange of information and have the potential of creating significant barriers and obstacles to trade unless there is full confidence and acceptance of international equivalence and compatibility of the conformity assessment (the verification) in accordance with the OIML International Recommendations.

The preventive effect intended by type approval and initial verification will be maintained provided the relevant conformity assessment is made internationally compatible and credible and if this is accomplished in a co-ordinated and committed way, without undue delay.

New research and development of measuring instruments tend to reduce the lifespan of instrument generations. This makes the time aspect of type approval crucial but above all it will dramatically increase the need for reasonable spot checks of marketed instruments to check maintained conformity to type approval requirements. This will keep the specialised legal metrology laboratories more than busy, it will contribute to maintain and develop their know-how and their ability to instruct verification personnel.

As global trade and exchange of information increase, as research and development to an ever-increasing extent open up new areas of measurement subject to regulatory control, the demand for conformity assessment (verification), estimated to engage more than a hundred thousand people around the globe, will also continue to increase, provided it is made internationally compatible.

The WTO requirement most important to legal metrology, the task most important to OIML.

Considering the enormous annual value of international trade of commodities quantified by measurement, the WTO Agreement requiring that procedures for conformity assessment do not create obstacles to international trade, becomes by far the most important WTO requirement to legal metrology and makes the promotion of full international compatibility of conformity assessment (verification) in accordance with the OIML International Recommendations by far the most important task for OIML.

In conclusion

- ♦ *When revising OIML Document 1, attention should be paid to the need of legal metrology legislation to fully comply with the WTO Agreement.*

XIV.

Annex II

A. Summing up efforts and initiatives to improve the efficiency and role of OIML.

B. Technical Committees and one ad hoc Working Group.

- ♦ Current lack of coherence in legislation relating to metrology makes it urgent for the Technical Committee 3 to address:
 - *a revision of OIML Document 1*
 - *attention should be paid to encourage more extensive use of legislative requirements for traceability in conformity assessment*
 - *attention should be paid to the need of legal metrology legislation to fully comply with the WTO Agreement on Technical Barriers to Trade.*
- ♦ To enable international uniformity and transparency in accreditation of legal metrology bodies the OIML Working Group on Accreditation in Legal Metrology should urgently take a strong lead, in close co-operation with ILAC,
 - *to create guidelines for establishing appropriately specific requirements for the competence of different legal metrology bodies operating conformity assessment procedures in trade, human health and safety, environmental and resource control and so on, to enable the ISO/IEC Guide 25 to be globally uniformly applied in the field of legal metrology.*
- ♦ To improve international compatibility of conformity assessment procedures operated by legal metrology bodies, the Technical Committees working programs should be enhanced by specifically addressing this when elaborating the methods and equipment for assessing conformity and by explicitly including the following elements in every new draft and revised International Recommendation:
 - *the appropriate uncertainty to be applied to the maximum permissible error of the instruments in question as well as for the working standards used for conformity verification*
 - *a specific section for appropriate reference standards and traceability chains, to be included in the listing of equipment for assessing conformity*
 - *a listing of specific instruments suitable for OIML IR-proficiency testing*
 - *making their expertise concerning the chosen and specified methods for assessing conformity available for the shooting of OIML training videos.*
- ♦ To improve international compatibility of compliance documentation, the Technical Committees working programs should be enhanced by specifically addressing this when elaborating the formats for reporting test results by explicitly including the following elements in every new draft and revised International Recommendation:
 - *formats for reporting conformity verification (verification certificates) and inspection (inspection certificates) to serve as OIML compliance documentation*
 - *formats for the confirmation of the measurement result to serve as the OIML measurement result confirmation.*

- ♦ To improve the services of legal metrology and support the establishment of multinational agreements of mutual recognition of equivalence of legal metrology reference standards, conformity assessment procedures and OIML compliance documents, the Technical Committees should take on:
 - *promoting and instigating the dissemination of equivalence established by key comparisons and to register areas in need of support at the level of key comparisons.*

C. OIML liaisons

- ♦ The current close liaison with WTO should be strongly supported and encouraged,
 - *with the objective of promoting international compatibility in the field of legal metrology by adoption of OIML International Recommendations.*
- ♦ The current internal co-operation between BIPM, ILAC and OIML should be strongly supported and encouraged,
 - *OIML should seek to use this forum to convey any particular needs at the level of key comparisons*
 - *targeted co-operation between on one hand OIML, BIPM and ILAC and on the other hand, carefully selected external partners, representing the ultimate users of metrology and the global measurement system should be strongly supported and encouraged.*
- ♦ To enhance the efficiency of the relations between OIML and the Regional Legal Metrology Bodies (RLMO) and promote compatibility of conformity assessment, a Joint Committee of the RLMO's and OIML (JCRO) should be created and mandated.
 - *JCRO should carefully select programs of OIML comparisons (reference standards) based on the relevant specifications of the various International Recommendations, and encourage their implementation by the regional legal metrology bodies*
 - *JCRO should carefully select programs of OIML IR-proficiency testing based on the relevant specifications of the various International Recommendations, and encourage their implementation by the regional legal metrology bodies.*

D. BIML Executive

- ♦ To improve the technical efficiency and productivity of OIML,
 - *a supplement to the OIML brochure should be carried out, if necessary with professional assistance, focusing on fostering relevant inter-relations at the national level to encourage active participation in OIML endeavours in all modern fields of legal metrology*
 - *a guide on the promotion of inter-departmental relation between national legal metrology bodies should be considered, and as far as possible assistance should be provided in such matters.*

- ♦ To improve international compatibility of conformity assessment procedures operated by legal metrology bodies,
 - *professional companies specialising in video production for training purposes should be engaged to produce OIML training videos.*
- ♦ To enhance transparency of international compatibility in the field of legal metrology,
 - *the results of OIML comparisons should be published in the OIML Bulletin*
 - *the results of OIML IR-proficiency testing should be published in the OIML Bulletin.*
- ♦ To improve the services of legal metrology and support the establishment of multinational agreements,
 - *BIML initiates and collects information from the Technical Committees about the dissemination of equivalence established by key comparisons and areas in need of support at the level of key comparisons.*

E. CIML

- ♦ To enhance transparency and confidence in conformity assessment,
 - *the principle of applying uncertainty to the maximum permissible error should be adopted.*
- ♦ To facilitate international compatibility of conformity assessment procedures operated by legal metrology bodies,
 - *each new or revised OIML International Recommendation should be attached the corresponding OIML training video.*

F. CIML Executive

- ♦ Sponsorship for activities that may be of particular interest or responsibility of certain sponsors;
 - *sponsorship should be sought for the production of OIML training videos*
 - *sponsorship should be sought for studies of the economic impact of changes in legal metrology infrastructures.*

G. Improving the role of CIML Members

- ♦ To enhance and promote inter-departmental relations between national legal metrology bodies,
 - *support or establishment of National Societies of Legal Metrology should be considered and encouraged by CIML Members .*

H. Improving the role of OIML

- ♦ The currently most important policy matters of OIML are to turn the present role in vital legal metrology matters into an active and leading role for OIML:
- ♦ *In order to enable OIML to assume its full and proper responsibilities for promoting international compatibility in the field of legal metrology, OIML will have to address the question of promoting formalisation of multinational agreements of mutual recognition of equivalence of*
 - *national legal metrology reference standards,*
 - *national legal metrology regulations and requirements,*
 - *national conformity assessment procedures,*
 - *certificates issued by national legal metrology bodies, i.e. OIML compliance documents.*
- ♦ *OIML should speed up the development of formalising a multinational recognition agreement on the OIML Certificate System.*
- ♦ *In order to enable OIML to assume its proper responsibilities for promoting international compatibility in all fields of legal metrology, OIML will have to address, in close co-operation with the respective users, the question of drafting the future policy of OIML in the fields of*
 - *legal metrology in health*
 - *legal metrology in safety*
 - *legal metrology in environmental protection*
 - *legal metrology in resource monitoring*
 - *legal metrology in chemistry.*

XV.

References

- 1 Convention establishing an International Organisation of Legal Metrology, 1955/1962.
- 2 John F. Kennedy, speeches.
- 3 "Measuring up to the Competition" UK White Paper on Metrology, 1989.
- 4 VIM, International Vocabulary of Basic and General Terms in Metrology, 1993.
- 5 VLM, Vocabulary of Legal Metrology, Fundamental Terms, Ed. 1978.
- 6 "Resource control by use of belt weighers in the fishing industry", Kleppan, Koren, Myklebust & Schultz, OIML Bulletin, Oct. 1997
- 7 J. Kovalevsky, Rapport, Académie des Sciences/CADAS sur la métrologie, 1995.
- 8 P. Clapham, "Measurement - for what it's worth" Engineering Science and Education Journal, Aug. 1992.
- 9 BIPM, "Mutual recognition agreement for national measurement standards and calibration certificates issued by national metrology institutes and Guidelines for key comparisons carried out by Consultative Committees", 15 May/21 July 1998.
- 10 P.A. DonVito, "Estimates of the cost of measurement in the US economy" NBS -84.
- 11 WTO Agreement on Technical Barriers to Trade.