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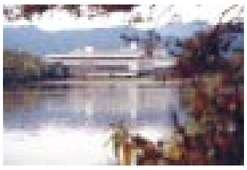

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Editorial

GERARD J. FABER

MANFRED KOCHSIEK

...Looking Back

When on Friday 6 November 2003 I had the honor of giving my last speech as CIML President I felt both contented and grateful, and I know that this was the right moment for me to step down.

The OIML is in rather good shape: interest in legal metrology is growing, and more countries are joining the OIML as Member States every year. The organization has a well-founded policy, a good action plan and is able to achieve its goals thanks to many highly committed metrologists all over the world and the hard working, enthusiastic staff at the BIML.

I am very grateful for the kind words the new Acting President and the BIML Director said to me during the OIML Reception in Kyoto, which was my last as President. This role was the "icing on the cake" for me and I loved it. Nevertheless, there are many things I was not able to accomplish. As I said in Kyoto, the OIML is making much progress, but is still too far from being a "champion" in legal metrology. A huge amount of work still has to be done, and I think that high priority must be allocated to finalizing the update of the so-called "Model Law", and of course to the actual implementation of the MAA, the adoption of which was for me one of the highlights of the Kyoto CIML Meeting.

This work will never end - and must never end. Even when the final goal is reached, namely a global and comprehensive metrology system, this system will have to be updated constantly in order to maintain it in line with all kinds of technological, political and other developments.

I will of course be closely following the activities of the OIML for as long as possible, and I offer my full support to the future leaders of the OIML. It has been a pleasure working with all of my legal metrology friends and colleagues, and a very memorable experience both personally and professionally. ■

Looking Forward ...

The outcome of the 38th CIML Meeting in Kyoto has led to my taking on the role of CIML Acting President, albeit quite unexpectedly. My activities for the year of presidency that lies ahead of me will basically be guided by the Decisions and Resolutions of the Kyoto meeting under the presidency of Mr. Faber, whom I again thank very much for his excellent leadership. I intend to prioritize the implementation of the MAA, including how to finance it and how to make a choice of one or two initial categories of measuring instruments. Another important point is the so-called "Model Law" in cooperation with ILAC and the BIPM.

The evaluation of the Birch Report and the outcome of the 2020 Seminar held in Saint-Jean-de-Luz in 2002 will also result in further actions in 2004, such as new projects for OIML Technical Committees in the fields of medicine and accreditation.

During the last years I have always personally stood up for a global measurement system outside the OIML and I will of course continue these efforts as CIML Acting President. I will pay special attention to the interests and problems of developing countries. Another topic is the preparation of the 12th Conference in Berlin in 2004, and one or two workshops which might deal with trade facilitator metrology and/or strengthening legal metrology in developing countries. I will also contact CIML Members with a view to encouraging them to become more actively involved, and try to convince other countries and economies to join the OIML.

The election of the CIML President in October 2004 has to be successful. So that we are all prepared sufficiently in advance, at this stage and while we still have slightly under a year in hand, I would like to invite all CIML Members to consider whether they wish to submit their candidacy for this election.

I look forward to this challenge and take the opportunity to wish all our Members and Readers a very successful New Year for 2004. ■

INDIRECT MEASUREMENTS

Moisture meters: A new certification approach
Humidimètres: Une nouvelle approche dans la certification

RÉGINE GAUCHER & ESTELLE SACCARDI
LNE, France

ENGLISH TRANSLATION

Introduction

Moisture meters, which are instruments used for the measurement of humidity of cereals in commercial transactions in France, have been subject to legal metrology control since 1973.

Since then their regulation has evolved, though it is still based on the same principle of validation.

1 The principle of validation of moisture meters

1.1 The principles of measurement

In all cases, the indication of the water content displayed by the moisture meter results from an indirect measurement obtained by converting a gross quantity which can be for example, according to the technology used, the dielectric permitivity, the light absorbance, etc.

In its memory, each moisture meter contains a library of conversion curves which for each type of grain will allow the gross measurement to be converted into an indication of water content, also taking into account other parameters such as the grain temperature.

In the case of a moisture meter based on electrical capacitance:

$H\ (\%) = f(\varepsilon_r, t, ...)$

Where H is the indication of water content,
ε_r is the relative electrical permitivity of the grain sample,
t is the temperature.

In the case of a moisture meter using infrared absorbance:

$H\ (\%) = f(\Delta\phi, t, ...)$

where $\Delta\phi$ is the variation of the flux (luminous).

ORIGINAL FRENCH TEXT

Introduction

L'humidimètre, instrument utilisé pour la mesure de l'humidité des graines de céréale en France, dans le cadre des opérations de commerce, est réglementé en tant qu'instrument de mesure depuis 1973.

Depuis cette date, cette réglementation a évolué cependant elle reste basée sur un même principe de validation des instruments.

1 Le principe de validation des humidimètres

1.1 Les principes de mesure

Dans tous les cas, l'indication de la teneur en eau délivrée par l'humidimètre résulte d'une mesure indirecte obtenue par la conversion d'une grandeur dite brute qui peut être selon la technologie de l'humidimètre, par exemple, la permittivité diélectrique, l'absorbance, etc.

Chaque humidimètre va donc disposer en mémoire d'une bibliothèque de courbes de conversion qui permettront, pour chaque espèce de grains, de convertir la mesure brute en une indication de titre en eau, en tenant compte également d'autres paramètres tels que la température du grain.

Dans le cas d'un humidimètre capacitif:

$H\ (\%) = f(\varepsilon_r, t, ...)$

Avec H l'indication de titre en eau,
ε_r la permittivité relative de l'échantillon de grain,
t la température.

Dans le cas d'un humidimètre infrarouge:

$H\ (\%) = f(\Delta\phi, t, ...)$

avec $\Delta\phi$: la variation du flux lumineux

1.2 The elaboration of the conversion curves

The elaboration of these curves is done from a determination of the reference value of humidity according to standardized methods such as for example the practical reference method defined in International Standard ISO 712.

This method is applied to samples of grains with their natural humidity as shown in Fig. 1.

The samples which are used for this determination are collected from crops in the process of being harvested for a given type of grain, including different varieties of this type and emanating from different regions.

The sampling process must take into account different parameters such as described in a, b, and c below:

a Exhaustivity of grain varieties

In order to avoid multiplying the number of conversion curves, the method consists in using a single conversion curve per type as far as possible. For example, a curve for corn could be used for the determination of the water content in different varieties such as waxy maize, flint dent maize, or dent maize. For this, it is necessary to have as many varieties as possible for the elaboration of the conversion curve.

b Influence of geographical conditions

Each region has different climatic conditions. In order to have as many different water contents as possible for

1.2 L'élaboration des courbes de conversion

L'élaboration de ces courbes de conversion s'effectue à partir d'une détermination de valeur de référence de l'humidité selon des méthodes normalisées telles que par exemple la méthode de référence pratique définie dans la Norme Internationale ISO 712.

Cette méthode est appliquée sur des échantillons de grains d'humidité naturelle (voir Fig. 1).

Les échantillons qui servent à cette élaboration sont prélevés sur des récoltes en cours pour une espèce donnée à partir de différentes variétés de cette espèce et dans différentes régions.

Les conditions de prélèvement doivent en effet permettre de tenir compte de différents paramètres tels que ceux donnés en a, b, et c ci-dessous:

a L'exhaustivité des variétés

Afin d'éviter de multiplier le nombre de courbes de conversion, la méthode consiste dans la mesure du possible à se limiter à une courbe de conversion par espèce. Par exemple, une courbe de maïs qui pourra être utilisée pour la détermination de la teneur en eau des différentes variétés de maïs telles que maïs waxy, maïs corné denté, maïs denté. De ce fait on note l'importance de disposer du plus grand nombre possible de variétés pour l'élaboration de la courbe de conversion.

b L'influence des conditions géographiques

Chaque région a ses spécificités climatiques, afin d'avoir un maximum de teneurs en eau différentes pour

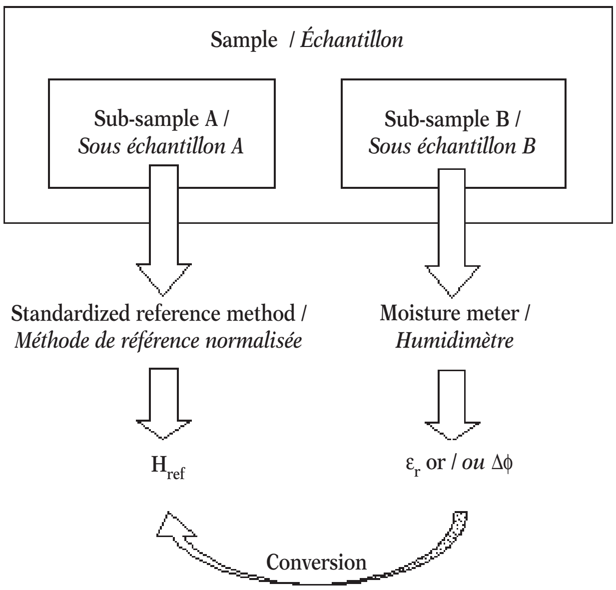

Figure 1

the elaboration of the conversion curves, it is necessary to take samples in the various different regions.

In addition, the nature of the soil is also an influence factor which also requires taking samples from different regions.

c Influence of climatic variations

Climatic conditions such as heavy rain or dry weather modify the characteristics of the grain, and especially the distribution of moisture inside the grains. This also justifies taking samples from different regions.

In addition, these climatic conditions vary each year and so the conversion curves have to be updated periodically.

The graph in Fig. 2 represents the accuracy curve of a moisture meter for a given type over three consecutive years without changing the conversion curve.

The curves corresponding to the different years show the necessity to adapt the conversion curves each year, and potentially more frequently.

Looking at the curve established for the 1998 crop, the high dispersions that appear for low humidity and for high humidity show the effect of the different varieties and different regions.

élaborer les courbes de conversion, il est donc nécessaire d'effectuer des prélèvements dans différentes régions.

D'autre part, la nature du sol de culture est également un paramètre d'influence qui justifie aussi d'effectuer des prélèvements d'échantillons dans différentes régions.

c L'influence des variations climatiques

Les conditions climatiques: fortes pluies, sécheresse, modifient les caractéristiques des grains et plus particulièrement la répartition de l'humidité au sein de ceux-ci. Le prélèvement d'échantillons dans différentes régions est nécessaire pour tenir compte de cette hétérogénéité.

En outre, ces variations climatiques vont être différentes d'une année sur l'autre. Ce qui conduit à réadapter périodiquement les courbes de conversion.

Le schéma en Fig. 2 représente la courbe d'exactitude d'un humidimètre pour une même espèce sur trois années consécutives sans changement de la courbe de conversion.

Les courbes correspondantes aux différentes années mettent bien en évidence la nécessité de réadapter au moins chaque année et le cas échéant plus fréquemment les courbes de conversion.

Si on regarde la courbe correspondant à l'année de récolte 1998, les grandes dispersions constatées en parties hautes et basses de la courbe mettent en évidence à la fois les facteurs liés aux disparités variétales et régionales.

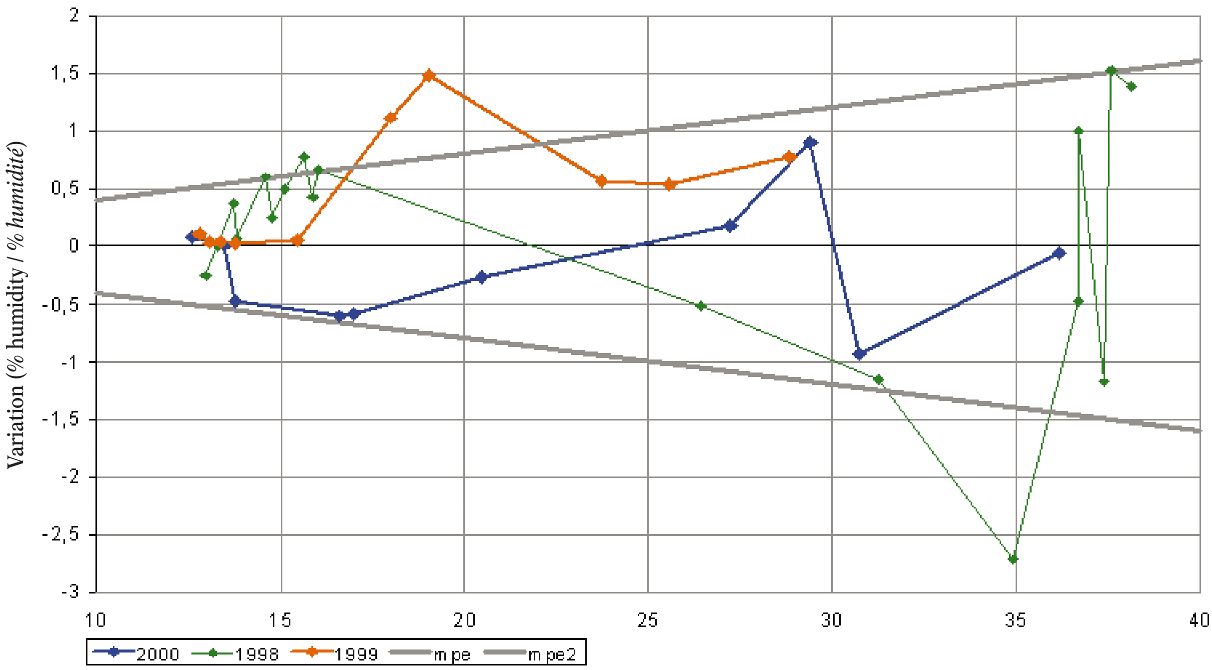

Figure 2 Curves for corn / *Courbes maïs*

The data available for analysis does not allow the influence of these two factors to be identified separately.

As a conclusion, it is not possible to have conversion curves identical throughout the country and constant over time. It is then necessary to set up a system which allows these factors to be taken into account.

2 Possible solutions

In order to eliminate all the influence factors described above, two solutions are possible:

a determining directly the water content, using reference methods (ISO 712 for example),

b having optimized conversion curves established and their evolution followed up by a central body in order to gain experience and better analyze the influence factors.

The implementation of reference methods such as those mentioned above is indeed a reliable solution but appears to be a heavy constraint in the field.

The solution proposed in b above requires the validation of the instrument itself (accuracy of the gross measurement) to be separated from the validation of the conversion curves.

The validation of the instrument might then be carried out with a standard conversion curve which would be independent from the factors related to the variety of grain, region and climate.

The validation of the conversion curves would then be carried out by the central body, using a transfer moisture meter according to the scheme in Fig. 3.

3 Conclusion

This study shows that the work on the revision of the requirements applicable to moisture meters must separate the validation of the instrument from the validation of the conversion curves. Cooperation between the various regions is of great importance.

France has recently started to revise its regulation on moisture meters taking into account the above-mentioned factors, and on the basis of the present ongoing revision of OIML R 59. ■

On note qu'il n'est pas possible aujourd'hui d'identifier la part de l'influence de chacun de ces deux facteurs.

En conclusion, on constate qu'il n'est pas possible d'avoir des courbes de conversion communes sur l'ensemble du pays et constantes au cours du temps. Il faut donc prévoir une solution qui permette de tenir compte de la réalité du terrain.

2 Solutions possibles

Afin de s'affranchir de tous les paramètres d'influence évoqués ci-dessus, deux solutions sont envisageables:

a Détermination de la teneur en eau directement à partir de méthodes de référence (ISO 712 par exemple),

b Gestion optimisée des courbes de conversion et de leur évolution par un organisme central afin d'obtenir un retour d'expérience qui permettra de mieux appréhender les facteurs d'influence.

L'utilisation des méthodes de référence telles que définies ci-dessus est certes une solution fiable mais qui se révèle lourde à mettre en œuvre dans le cas d'une application systématique sur le terrain.

La solution proposée en b. nécessite de dissocier la validation de l'instrument lui-même (exactitude la mesure brute) de la validation des courbes de conversion. La validation de l'instrument pourrait alors être réalisée à partir d'une courbe de conversion type qui serait indépendante des facteurs liés aux variétés à la région et au climat.

La validation des courbes de conversion serait alors faite par l'organisme central au moyen d'un humidimètre de transfert selon le schéma en Fig. 3.

3 Conclusion

Cette étude montre que les travaux d'évolution des exigences relatives aux humidimètres doivent être poursuivis dans le sens: d'une séparation de la validation de l'instrument et de la validation des courbes de conversion et d'une coopération avec d'autres régions.

La France a engagé récemment une révision de sa réglementation nationale en tenant compte des éléments évoqués ci-dessus et sur la base des travaux en cours de la révision de la Recommandation OIML R 59 relative aux humidimètres. ■

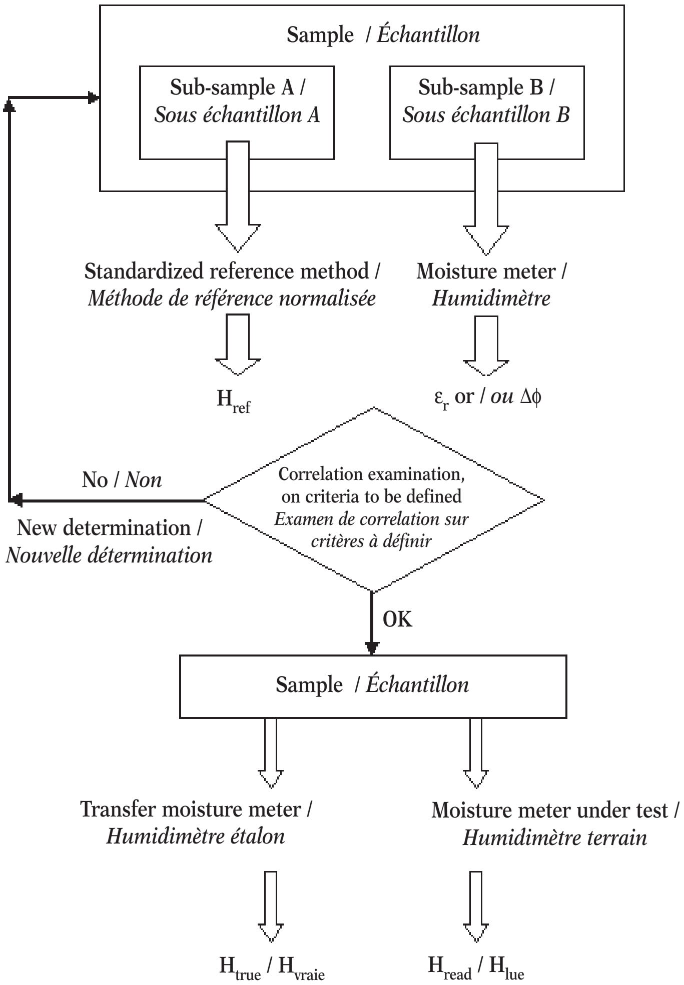

Figure 3

Comments by J.F. Magaña (BIML)

This article on moisture meters shows the difficulty raised by all instruments which provide indirect measurements, i.e. instruments which measure a quantity and then calculate another quantity which is more or less correlated with the first one.

Other examples of such indirect measurements, among others, are:

- refractometers, which measure the refractive index of sugar solutions and give the sugar content (which is then converted into a probable alcohol percentage in wine),
- polarimetric saccharimeters, which measure the rotation of the polarization plane in a sugar solution and determine the saccharose content in the solution,
- breath analyzers, which measure the concentration of certain radicals in the breath and display the concentration of ethanol in the breath (in some countries, these breath analyzers convert this into concentration of alcohol in the blood),

Commentaires de J.F. Magaña (BIML)

Cet article sur les humidimètres montre la difficulté rencontrée avec tous les instruments fournissant des mesures indirectes, à savoir de mesurer une grandeur et de calculer une autre grandeur plus ou moins en corrélation avec la première.

Parmi d'autres, il existe également les exemples suivants de mesures indirectes:

- les réfractomètres, qui mesurent l'indice de réfraction des solutions sucrées et indiquent la teneur en sucre (qui est ensuite convertie en un pourcentage d'alcool probable dans les vins),
- les saccharimètres polarimétriques, qui mesurent la rotation du plan de polarisation dans une solution sucrée et déterminent la teneur en saccharose dans la solution,
- les éthylomètres, qui mesurent la concentration de certains radicaux de l'air expiré et affichent la concentration d'éthanol de l'air expiré (dans certains pays, ces éthylomètres la convertissent en concentration d'alcool dans le sang),

- instruments which measure the speed of vehicles and the time elapsed between two vehicles, and then calculate the distance between them,
- heat meters, which measure the flow rate and temperature of a fluid and display the enthalpy lost in a circuit, provided that the liquid is pure water.

Of course any measurement in any field of metrology is indirect. But in the cases mentioned here, a property of a product is evaluated by measuring another property (humidity from capacitance, etc.). This may be difficult with natural products, which are very variable.

Legal metrology must be very careful with such indirect measurements. When the correlation between the measured quantity and the displayed quantity is good and when influence factors cannot significantly alter this correlation, indirect measurements do not raise problems. In other cases, the complexity of influence factors can result in poor reliability of the converted measurement. The graph in this article shows that without taking influence factors into consideration, the standard deviation of the measurements at high or low humidity significantly reduces their reliability. One example which is far from satisfactory is breath analysis. When regulations have to take exceptions in the measurement validity into account for a number of gases which might be present in breath due to diseases or medicines, the level of confidence in the instruments is not satisfactory. And when such influence factors have a dominant effect, this can encourage fraud.

Without adequate precautions being taken, indirect measuring instruments cannot stay within the prescribed error limits, or alternatively the regulators will have to set unacceptably large maximum permissible errors. The measurement results given by such instruments may be criticized and questioned, and such doubts could then be extended to the whole legal metrology field. Legal metrology authorities must continuously make sure that comparisons between indirect measurements by type approved instruments, and direct measurements obtained by reference methods, show the acceptability of the indirect measurements.

Only two alternatives are acceptable in legal metrology:

- either the indirect measurement is not significantly affected by influence factors (compared with the maximum permissible error), and this has to be well demonstrated,
- or the influence factors may have important consequences, in which case they must be taken into account in the use of the instrument.

A set of error curves for the instrument, depending on the values of the influence factors as proposed in this article, is one solution. One can note that this is done with turbines for liquid measurement. When these turbines are approved for a wide range of viscosities, they have different error curves for different viscosity ranges. The pulse value of the turbine or the correction curve has to be adjusted to the nature of the liquid, or the instrument has to detect the viscosity range and use the appropriate curve.

- les instruments mesurant la vitesse des véhicules et le temps écoulé entre deux véhicules et ainsi évaluant la distance entre les véhicules,
- les compteurs d'énergie thermique, qui mesurent le débit et la température d'un fluide et affichent la perte d'enthalpie dans un circuit à condition que le liquide soit de l'eau pure.

Évidemment, tout mesurage dans tout domaine de la métrologie est indirect. Mais dans les cas mentionnés ici, une propriété d'un produit est évaluée par le mesurage d'une autre propriété (humidité à partir de la capacitance, etc.). Cela peut s'avérer très délicat avec les produits naturels qui sont très variables.

Les mesurages indirects doivent être conduits avec beaucoup de précautions dans le cadre de la métrologie légale. S'il y a une bonne corrélation entre la grandeur mesurée et celle affichée, et si les facteurs d'influence ne peuvent altérer significativement cette corrélation, les mesurages indirects ne posent pas de problème. Sinon, la complexité des facteurs d'influence peut se traduire par un manque de fiabilité de la mesure convertie. Le graphique du présent article indique que si l'on ne tient pas compte des facteurs d'influence, la fiabilité des mesures pour une humidité élevée ou une faible humidité sera sensiblement réduite par leur écart-type. Pour autre exemple, l'utilisation des éthylomètres est aussi sujette à caution. Lorsque la réglementation doit faire des exceptions sur la validité de la mesure pour un grand nombre de gaz pouvant être présents dans la respiration en raison de certaines maladies ou de certains médicaments, le niveau de confiance dans les instruments n'est pas satisfaisant. Il faut aussi garder à l'esprit que si les facteurs d'influence ont un effet dominant, cela peut inciter à la fraude.

Sans des précautions adéquates, les instruments exécutant des mesures indirectes ne permettent pas de respecter les limites d'erreur, à moins que les organismes de contrôle ne décident de prescrire des erreurs maximales tolérées excessivement larges. Les résultats de mesure donnés par de tels instruments peuvent être critiqués et mis en doute, et ces contestations pourraient ensuite s'étendre à l'ensemble du secteur de la métrologie légale. Les autorités de métrologie légale doivent en permanence s'assurer que les comparaisons entre les mesures indirectes par des instruments dont les modèles sont approuvés, et les mesures directes obtenues par des méthodes de référence, prouvent que les mesurages indirects sont acceptables.

En métrologie légale, deux alternatives seulement sont acceptables:

- soit le mesurage indirect n'est pas affecté de façon significative par des facteurs d'influence (par comparaison avec l'erreur maximale tolérée), et cela doit être clairement démontré,
- soit les facteurs d'influence peuvent avoir des conséquences importantes, et doivent dans ce cas être pris en compte pour l'utilisation de l'instrument.

Un ensemble de courbes d'erreur de l'instrument, en fonction des valeurs du facteur d'influence, tel que proposé dans cet article est une solution. On peut noter qu'il en est ainsi pour les turbines de mesurage des liquides. Lorsque ces

Correlations are to be demonstrated and influence factors have to be analyzed. This may be quite difficult for natural products, and advanced statistical methods may be necessary (analysis of variance, analysis of the main components, etc.). Systematic experimentation is generally not possible with natural products, and databases of available measurements must be developed. This could be an OIML action to facilitate networking on these issues among Member States, and to set up international databases of measurement and calibration data, these databases being based on information supplied by participating national institutes of Member States and allowing such analysis. ■

turbines sont approuvées pour une grande étendue de viscosité, elles sont caractérisées par des courbes d'erreur différentes pour les diverses étendues de viscosité. La valeur d'impulsion de la turbine ou la courbe de correction doit être ajustée selon la nature du liquide, sinon l'instrument doit détecter l'étendue de viscosité et utiliser la courbe appropriée.

Les corrélations doivent être démontrées et les facteurs d'influence analysés. Cela peut s'avérer compliqué pour les produits naturels, et des méthodes statistiques sophistiquées peuvent être nécessaires (analyse de variance, analyse en composantes principales, etc.). Une expérimentation systématique n'est généralement pas possible avec les produits naturels et des bases de données des mesures disponibles doivent être constituées. Une action de l'OIML pourrait faciliter la mise en réseau de ces résultats pour diffusion auprès des États Membres, et mettre en place des bases internationales de données de mesure et d'étalonnage, qui seraient alimentées par les instituts nationaux des États Membres participants et permettraient d'effectuer les analyses en question. ■

UNCERTAINTY

Uncertainty of measurement calculations for the "Weighing Performance Test" under OIML R 76

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Abstract

This paper describes NWML's approach to measurement uncertainty evaluation in the weighing performance test carried out during type approval of nonautomatic weighing instruments under OIML R 76 [1]. The results show that although the maximum permissible errors (mpe) for these instruments are generally sufficient to cater for the uncertainties encountered during the testing, care must be taken to ensure that the test methods do not introduce excessive errors during the evaluation of the instrument.

Introduction

Within Europe, laboratories carrying out EC type examination of nonautomatic weighing instruments must meet the requirements of WELMEC Guide No. 4.1 [2]. One of the requirements of the Guide is: '*In view of the importance of test results at the type examination stage the uncertainty of the system used in EC-type examination shall not be greater than 1/5 of the maximum permissible error*.' Additionally, it is NWML's policy to carry out type approval testing of nonautomatic weighing instruments in compliance with ISO/IEC 17025 [3]. This standard also has a requirement that uncertainties are evaluated.

The general approach to evaluating and expressing uncertainty is based on the recommendations produced by the International Committee for Weights and Measures or *Comité International des Poids et Measures* (CIPM). This is described in the Guide to the Expression of Uncertainty in Measurement (GUM) [4].

1 Uncertainty evaluation for type examination testing

1.1 Background to uncertainties of measurement

In 1981 the need for an internationally accepted procedure for expressing measurement uncertainty led to the international authority in metrology, the CIPM, approving brief outline recommendations submitted by a working group of representatives from the major national standards laboratories. The International Organisation for Standardisation [ISO] was then given the task of developing a detailed guide applicable to all levels of accuracy from fundamental research to shop floor operations. The responsibility for the preparation of such a comprehensive document for this broad spectrum of measurements was assigned to a working group of the ISO Technical Advisory Group on Metrology [ISO/TAG4/WG3]. The working group produced the ISO TAG4 *Guide to the Expression of Uncertainty in Measurement* (The "GUM") in 1993; this document was revised in 1995.

GUM 3.4.8 states: "*Although this Guide provides a framework for assessing uncertainty, it cannot substitute for critical thinking, intellectual honesty, and professional skill. The evaluation of uncertainty is neither a routine task nor a purely mathematical one; it depends on detailed knowledge of the nature of the measurand and of the measurement. The quality and utility of the uncertainty quoted for the result of a measurement therefore ultimately depend on the understanding, critical analysis, and integrity of those who contribute to the assignment of its value.*"

1.2 The importance of uncertainty of measurement

Basic to all science and engineering is that the making of measurements and the collection of measurement results is usually achieved by establishing a measurement procedure. Once the measurements have been made they must be organised, evaluated and the results interpreted. It has long been recognised that most measurements in calibration and testing work are subject to errors which are not perfectly quantifiable and that, therefore, there is uncertainty associated with the results of such measurements. A measurement result is clearly incomplete, and of extremely limited use in research, development, conformity assessment, calibration and production without a statement of the corresponding measurement uncertainty.

1.3 Reporting and evaluation of uncertainty

The complexity of tests may in some cases preclude a rigorous evaluation of uncertainty. In such cases, at least a list of the potential contributors to uncertainty can be made and include reasonable estimates of the magnitude of each component uncertainty. One of the most important aspects of uncertainty evaluation is the need for a detailed understanding of the measurement process and hence all potential sources of the measurement uncertainty. The identification of uncertainty sources begins by examining the measurement process in detail. There is a lot of thinking time during the early stages of uncertainty formulation. All aspects of the test have to be considered and any potential sources of uncertainty identified. A clear grasp of the exact reason for the test and what it is trying to prove is required at this stage so usually there are factors which are not important for the test result and so can be ignored.

1.4 Sources of uncertainty

The measurement procedure must be studied in detail and then an initial list of factors having an influence on the test result noted down. Each aspect which influences the test will then be considered individually in more detail and then the contribution type is decided upon.

Typical contributions would be:

- Environmental conditions;
- Equipment calibration and acceptability factors;
- Instrument resolution;
- Drift;
- Errors in values of constants used in correction formulae;
- Errors associated with formulae used to correct data;
- Repeatability of the test using different observers; and
- Assumptions or approximations made in the measurement process.

There are two types of uncertainty contributions labelled type A or type B.

Type A contributions are based on analysis of a number of repeat readings, to obtain the standard deviation. The number of observations must be large enough to obtain the desired level of uncertainty. If the actual test is performed more than once, this standard deviation is divided by the square root of ‘n’ where ‘n’ is the number of times the particular test is carried out. This is because every time a test is repeated, knowledge of the measurand increases.

Type B contributions are those obtained by non statistical methods, e.g. previous measurement data, experience or knowledge of the measurement system and materials used, manufacturer’s specification, calibration certificates, quoted uncertainties of reference data quoted in handbooks. Type A contributions are usually gaussian distributions with n–1 degrees of freedom (where n is the number of repeatability measurements made). Type B are usually rectangular, occasionally triangular or gaussian with an infinite number of degrees of freedom if they are uncertainties taken from calibration certificates or the manufacturer’s specifications.

All the standard uncertainty contributions of an uncertainty budget must be in the same units. In most cases the input quantity will be in the same units as the associated output quantity. However, this is not always the case. For example, how will a unit change in temperature affect the weight of an object? A sensitivity coefficient has to be determined in these cases so that it is known that a unit change in the input quantity will produce a known change in the output quantity. This is then used as a factor by which the input quantity is multiplied to obtain the effect in terms of the measurement result. Sensitivity coefficients can be determined using formulae and partial differentiation or by numerical means, often with the help of spreadsheets.

1.5 Expanded uncertainty

All the contributions are combined by the root sum square combination to produce a standard uncertainty. The standard uncertainty is then multiplied by a coverage factor k usually ranging between 2 and 3 calculated using statistical methods to give an uncertainty at a level of confidence of 95.45 % (approximately 95 %).

1.6 Calculation of the budget

Once all the contributions and sensitivity coefficients have been established and the distribution types decided upon, the budget can be calculated using the standard formulae contained in the GUM. A computer spreadsheet is well suited to perform the calculations.

1.7 Uncertainties in relation to pass/fail criteria of an instrument - the shared risk concept

In the field of legal metrology, measurement results, maximum permissible errors, and pass/fail criteria must be unambiguous so that they are not subject to challenge in a court of law. The shared risk concept is thus applied. This is defined in WELMEC Guide 4.1 as follows:

> "The uncertainty of test results has to be handled in a uniform way. In accord with the general view and tradition in legal metrology, the 'shared risk concept' will generally be applied. This means that provided the uncertainty of the test system is small compared to the limits of error for instruments under test, uncertainty is not considered when using the test result for the conformity assessment procedure. In this way there will be an equally shared risk that a test result for an instrument on the borderline of the tolerances will be inside or outside these limits."

2 Example uncertainty budget calculation - R 76 Weighing Performance Test

2.1 Background to test

This uncertainty evaluation covers the weighing performance test (A.4.4.1) under OIML R 76 on a Class III nonautomatic weighing instrument. The errors are reported in terms of "e", the verification scale interval. The uncertainty of measurement will be expressed in terms of "e".

A scale with 3 kg Max, scale interval e = 1 g, and 3000 divisions, with high-resolution capability has been used for random effect experiments. The "e" of this scale has also been used to enter all other uncertainties involved in this test. Most weighing instruments now have high-resolution capabilities, but if this is not available, change point weights of 0.1 e are used.

R 76 requires that errors are evaluated "under normal test conditions", that is: "errors shall be determined under normal test conditions. When the effect of one factor is being evaluated, all other factors are to be held relatively constant, at a value close to normal." It should be noted that contributions obtained experimentally using a weighing machine, e.g. the repeatability standard deviation, may include a factor due to a change in instrument performance in addition to the variations due to the measurement procedure and the test person.

Uncertainties have been evaluated at four points in the weighing range (the mpe changes as one moves up the weighing range):

- Zero (10 e);
- 500 e;
- 2000 e;
- Max (3000 e).

2.2 Assessment of influences that may have an effect on the accuracy of measurements

2.2.1 Calibration of weights

All weights used are calibrated with F_2 uncertainties by a UKAS accredited calibration laboratory. Weight values are reviewed at each re-calibration to ensure that no weights are outside of M_1 tolerances. Because we do not yet have satisfactory long-term drift figures, M_1 error limit values are used in the uncertainty calculations (the F_2 calibration uncertainty is small compared to the M_1 limit and is therefore ignored). This contribution is considered to be rectangular, as the value is an offset from nominal.

M_1 error limits:

- 10 g 0.002 e;
- 500 g 0.025 e;
- 2000 g 0.100 e; and
- 3000 g 0.150 e.

2.2.2 Tilt of instrument

The effect of tilt on the instrument is tested elsewhere during the conformity assessment to OIML R 76/EN45501. It is a requirement that the instrument under test is levelled before testing is commenced. The effect of tilt can therefore be disregarded.

2.2.3 Eccentricity of applied load

The effect of eccentric loading of the instrument is what is being tested for during the random effect testing performed and shown later in this report. All test engineers performing this test would have been trained to place weights as close to the centre of the weighing platform as possible, and to use the largest single weight available and not use multiple weights for each weighing level. This would be checked periodically during internal and external audits of the test. The effect of eccentric loading is therefore ignored as a separate issue.

2.2.4 Stability of the table on which the test instrument is placed

All tables used in the laboratory are made of solid construction and are therefore not liable to unsteadiness or flexing during weighing tests performed with the level of masses applied to all scales being tested at table height. If large weights are used, the scale is placed on the laboratory floor. The effect of table instability is zero and is therefore disregarded.

2.2.5 Force applied when applying test weights

All testing requires that the load "is gently placed on the load receptor". The effect of the force applied during loading is probably minimal but is included in the random effect testing influences shown later in this report.

2.2.6 Time dependence (creep)

The effect of creep on the results of a measurement can only be accurately measured after the instrument is subjected to a creep test. This is because the assessment of the effect of creep on the uncertainty of results of this test, for all measurements, can only be assessed for the time period of the test itself. The average time span of the test is 15 minutes and weights are not left on for longer than this. The creep effect would therefore be negligible. The creep test is also performed at maximum load so as far as the uncertainty of measurement is concerned, this effect will be disregarded.

2.2.7 Electrical disturbance during test

The electrical environment of the laboratory is considered to be "clean". Also, the instrument is tested separately for immunity to electrical disturbances so will not be affected should disturbances arise. The contribution is therefore disregarded.

2.2.8 Random errors due to test person or testing method

This effect will also include repeatability of performing this test. To assess this effect the testing was performed ten times by one test person over a one-month period with different lengths of instrument warm-up and reset of instrument levelling on each occasion. The test was then performed five times by an experienced test person and five times by a new test person. This gave a final figure of twenty repeated tests. The standard deviation for each weight level on both increasing and decreasing load was calculated and the largest of these figures used for the uncertainty.

Table 1 shows the results of measurements made by different test persons and gave a highest standard deviation of:

- 0 g at 10 e;
- 0.022 g at 500 e;
- 0.057 g at 2000 e; and
- 0.044 g at 3000 e.

2.2.9 Digital rounding error, comparison

If the error of indication is determined using the 0.1 e digit of the instrument display (which most modern electronic scales have), then the standard uncertainty would be 0.1 e/√6 = 0.04 e. The √6 divisor is used (i.e. a triangular distribution) as the results are determined from two readings giving a comparison digital rounding error in accordance with UKAS M3003, H4.4 [5].

2.2.10 Calibration of change-point weights

If the scale does not have the extra digit then up to 13 change-point weights of 0.1 e may be used to determine the error. The weights are calibrated to F_2 uncertainty and adjusted to the M_1 tolerance window. This contribution is included in the budgets below, although change-point weights are not always used in practice.

M_1 tolerance for 0.1 g = ± 0.000 5 e

The contribution, if there is no correlation between calibration of the change-point weights, would be the root sum of squares of thirteen of ± 0.0005 e = ± 0.0018 e. However, to meet the requirements of OIML R 111 [6] B.2.2.2 (combinations of reference weights), the contribution is the arithmetic sum of thirteen of ± 0.0005 e = ± 0.0065 e.

2.2.11 Aerodynamics

Tests being performed in the controlled laboratory environment are in still air so that little effect of laminar airflow or positive pressure would be seen. Also, the effect of this at the accuracy levels tested at for Class III instruments would be very small with the little airflow experienced in the test areas. This effect is therefore not considered significant enough to enter an estimate of uncertainty.

2.2.12 Variations in gravity 'g'

The instrument is tested in the same position therefore there is no variation in 'g' during the testing period. The effect is therefore disregarded.

2.2.13 Effect of air buoyancy

The effects of air buoyancy are included in the uncertainty of the mass calibrations and as testing is performed in the controlled laboratory environment the effect would, from figures obtained from Kaye & Laby [7], be very small compared to other influences. The combination of this would have no effect on the resultant uncertainty budget level. The effect is therefore not included in the uncertainty estimation.

2.3 Calculation of the influences

The repeatability results are shown in Table 1 of the Annex, and the uncertainty budget calculations of the influences for the selected weight denominations can be seen in Tables 2 to 5.

3 Summary and recommendation

The uncertainty of measurement calculated for the weighing performance test on a Class III weighing instrument having 3000 divisions has an expanded uncertainty at a confidence level of approximately 95 % as follows:

Test point	Uncertainty	Error limit	1/5 of the error limit
10 e	0.082 e	0.5 e	0.1 e
500 e	0.097 e	0.5 e	0.1 e
2000 e	0.182 e	1.0 e	0.2 e
3000 e	0.211 e	1.5 e	0.3 e

At each test point, the measurement uncertainty is within the target 1/5 of the mpe for this class and capacity of instrument.

It should be noted that the uncertainty increases with increasing capacity of the weighing instrument. This is mainly due to the requirement that the uncertainty of the test weights must be summed together, and so the uncertainty will increase with the number of test weights used.

It is therefore recommended that the number of test weights used for the weighing performance test is kept to the minimum, consistent with being able to place a "steadily increasing/decreasing load" on the load receptor. Alternatively for a Class III instrument, consideration should be given to using F_2 weights in place of M_1 weights. ■

References

[1] OIML R 76-1 *Nonautomatic weighing instruments Part 1: Metrological and technical requirements - Tests*

[2] WELMEC 4.1 *Guide for the assessing and operation of notified bodies performing conformity assessment according to the Directive 90/384/EEC*

[3] IS0/IEC 17025:2000 *General requirements for the competence of testing and calibration laboratories*

[4] PD 6461: Part 3: 1995 *Vocabulary of metrology Part 3. Guide to the expression of uncertainty in measurement*

[5] UKAS M3003 *The expression of Uncertainty and Confidence in Measurement*

[6] OIML R 111 *Weights of classes E_1, E_2, F_1, F_2, M_1, M_2, M_3*

[7] G.W.C. Kaye & T.H. Laby *Tables of Physical and Chemical Constants and some Mathematical Functions*

ANNEX

Test results of a scale with 3 kg Max, scale interval e = 1 g, and 3000 divisions, with high-resolution capability

Table 1 - repeatability measurements

	10 g	20 g	40 g	100 g	500 g	1 kg	2 kg	3 kg	2 kg	1 kg	500 g	100 g	40 g	20 g	10 g
A	10	20	40	100	499.9	1000	1999.9	3000	2000	1000	500	100	40	20	10
A	10	20	40	100	500	1000	2000	3000	1999.9	1000	500	100	40	20	10
A	10	20	40	100	500	1000	2000	3000	2000	1000	500	100	40	20	10
A	10	20	40	100	500	1000	2000	3000	2000	1000	500	100	40	20	10
A	10	20	40	100	500	1000	2000	3000	1999.9	1000	500	100	40	20	10
A	10	20	40	100	500	1000	2000	3000	1999.9	1000	500	100	40	20	10
A	10	20	40	100	500	1000	2000	3000	2000	1000	500	100	40	20	10
A	10	20	40	100	500	1000	2000	3000	2000	1000	500	100	40	20	10
A	10	20	40	100	500	1000	2000	3000	2000	1000	500	100	40	20	10
A	10	20	40	100	500	1000	2000	3000	1999.9	1000	500	100	40	20	10
B	10	20	40	100	500	1000	2000	2999.9	2000	1000	500	100	40	20	10
B	10	20	40	100	500	1000	2000	2999.9	2000	1000	500	100	40	20	10
B	10	20	40	100	500	1000	2000	2999.9	2000	1000	500	100	40	20	10
B	10	20	40	100	500	1000	2000	2999.9	2000	1000	500	100	40	20	10
B	10	20	40	100	500	1000	2000	2999.9	2000	1000	500	100	40	20	10
C	10	20	40	100	500	1000	2000	3000	2000	999.9	500	100	40	19.9	10
C	10	20	40	100	500	1000	2000	3000	2000.1	1000.1	500.1	100	40	20.1	10
C	10	20	40	100	500	1000	2000	3000	1999.9	1000	500	99.9	40	20	10
C	10	20	40	100	500	1000	2000	3000	1999.9	1000	500	100	40	20	10
C	10	20	40	100	500	1000	2000	3000	1999.9	999.9	500	99.9	39.9	20	10
sd	0	0	0	0	0.022	0	0.022	0.044	0.057	0.039	0.022	0.031	0.022	0.032	0

A = test person A
B = test person B
C = test person C
sd = standard deviation

Table 2 - Uncertainty calculation at 10 e

Parameter	Type A or B	Distribution: Gaussian σ_{n-1}	Gaussian 95%	Rectangular Semi-range	Triangular Semi-range	Divisor	Standard Uncertainty $u(x)$	Sensitivity Coefficient c_i	Contribution u_i	ν_i
Calibration of 10 g weights	B			0.002 g		√3	0.001 g	1	0.001 g	∞
Random operator effect	A	0 g				1	0 g	1	0 g	19
Resolution of indicator	B				0.1 g	√6	0.041 g	1	0.041 g	∞
Calibration of 13 x 0.1 e change-point weights	B			0.006 5 g		√3	0.004 g	1	0.004 g	∞

Root sum of squares (RSS) = 0.041 g

Coverage factor k = 2

Uncertainty at approximately 95 % = 0.082 g = 0.082 e

Table 3 - Uncertainty calculation at 500 e

Parameter	Type A or B	Distribution: Gaussian σ_{n-1}	Gaussian 95 %	Rectangular Semi-range	Triangular Semi-range	Divisor	Standard Uncertainty $u(x)$	Sensitivity Coefficient c_i	Contribution u_i	ν_i
Calibration of 500 g weights	B			0.025 g		√3	0.014 g	1	0.014 g	∞
Random operator effect	A	0.022 g				1	0.022 g	1	0.022 g	19
Resolution of indicator	B				0.1 g	√6	0.041 g	1	0.041 g	∞
Calibration of 13 x 0.1 e change-point weights	B			0.006 5 g		√3	0.004 g	1	0.004 g	∞

RSS = 0.049 g

Coverage factor k = 2

Uncertainty at approximately 95 % = 0.097 g = 0.097 e

Table 4 - Uncertainty calculation at 2000 e

Parameter	Type A or B	Distribution Gaussian σ_{n-1}	Gaussian 95 %	Rectangular Semi-range	Triangular Semi-range	Divisor	Standard Uncertainty $u(x_i)$	Sensitivity Coefficient c_i	Contribution u_i	ν_i
Calibration of 2 kg weights	B			0.1 g		√3	0.058 g	1	0.058 g	∞
Random operator effect	A	0.057 g				1	0.057 g	1	0.057 g	19
Resolution of indicator	B				0.1 g	√6	0.041 g	1	0.041 g	∞
Calibration of 13 x 0.1 e change-point weights	B			0.0065 g		√3	0.004 g	1	0.004 g	∞

RSS = 0.091 g

Coverage factor k = 2

Uncertainty at approximately 95 % = 0.182 g = 0.182 e

Table 5 - Uncertainty calculation at 3000 e

Parameter	Type A or B	Distribution Gaussian σ_{n-1}	Gaussian 95 %	Rectangular Semi-range	Triangular Semi-range	Divisor	Standard Uncertainty $u(x_i)$	Sensitivity Coefficient c_i	Contribution u_i	ν_i
Calibration of 3 kg weights	B			0.15 g		√3	0.144 g	1	0.087 g	∞
Random operator effect	A	0.044 g				1	0.044 g	1	0.044 g	19
Resolution of indicator	B				0.1 g	√6	0.041 g	1	0.041 g	∞
Calibration of 13 x 0.1 e change-point weights	B			0.0065 g		√3	0.004 g	1	0.004 g	∞

RSS = 0.105 g

Coverage factor k = 2

Uncertainty at approximately 95 % = 0.211 g = 0.211 e

TERMINOLOGY

The relationship between calibration, verification and metrological confirmation

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Abstract

Calibration is an important activity in both legal and industrial metrology: it is the only way to effectively carry out traceability in both fields. Calibration is a technical activity that has little to do with the management of measuring instruments, and verification procedures include calibration procedures. Verification and metrological confirmation respectively control the application of instruments in legal and industrial metrology.

Introduction

This article follows on from the paper published in the January 2001 OIML Bulletin entitled *Calibration and verification: Two procedures having comparable objectives and results*. Much has been learned from this paper, but to a certain extent the author of the present article has a different point of view concerning the relationship between calibration and verification as described in that paper and wishes to open up the topic for further discussion.

Calibration and verification are familiar terms in metrology, but a new term *metrological confirmation* has appeared since ISO 10012-1 was published. The author feels that clarification of the relationship between these terms would be meaningful and of benefit to metrology terminology, measurement management and communication between metrologists. This paper will discuss the relationship between these terms.

1 The verification procedure includes the calibration procedure

Firstly, the relationship between these terms based on their definitions will be discussed.

The definition of **calibration** in the VIM is as follows [VIM 6.13]: *A set of operations which establish, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, or values represented by a material measure, and corresponding known values of a measured quantity.*

Notes

1) The result of calibration permits either the assignment of measurand values to the indication, or the determination of corrections with respect to the indications.
2) Calibration may also determine other metrological properties such as the effect of influence quantities.
3) The calibration result may be recorded in a document, sometimes called a calibration certificate or calibration report.

From this definition, we know that the purpose of calibration is the determination of the metrological properties. It is a technical activity and has no management meaning (i.e. it has no technical or legal management requirements).

Definitions of **verification** of a measuring instrument are published in the following three documents:

i) VIML 2.13

Procedure (other than type approval) which includes the examination and marking and/or issuing of a verification certificate, that ascertains and confirms that the measuring instrument complies with the statutory requirements.

ii) ISO/IEC Guide 25 (1990)

Confirmation by examination and provision of evidence that specified requirements have been met.

Notes

1) In connection with the management of measuring equipment, verification provides a means for checking that the deviations between the values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum permissible error defined in a standard, regulation or specification which is specific to the management of the measuring equipment.
2) The result of verification leads to a decision either to restore to service, perform adjustments, repair, downgrade, or declare obsolete. In all cases, it is

required that a written trace of the verification performed be kept on the measuring instrument's individual record.

3) ISO/IEC Guide 25, 3.8, amended
(quoted from ANSI/NCSL Z540-1-1994)

Evidence by calibration that specified requirements have been met.

Notes

1) The same applies as in Note 1 to ISO Guide 25 (1990) above.
2) The result of verification leads to a decision either to restore to service, perform adjustments, repair, downgrade, or declare obsolete. In all cases, documentation of the verification performed shall be kept on the measuring instrument's individual record.

From these definitions, it can be said that the verification procedure includes the calibration procedure, even though the word "calibration" is not mentioned in the first and second definitions. What is stated in the first note to the second definition actually describes calibration. And from OIML Recommendations, we know that there are three kinds of statutory requirements: metrological, technical and legal management. So, the word "examination" in the first definition also includes calibration. Calibration is a basic and key procedure in verification, and forms the technical basis thereof. From the author's point of view, it may be better and clearer if the definition of verification was amended as follows:

Evidence by calibration and checking of legal requirements that the statutory requirements specified in the relevant regulations have been met.

The author believes that the word "examination" is not as clear and accurate as the words "calibration" and "checking of legal requirements".

2 Metrological confirmation strengthens instrument management in industry

Now there is another expression, "metrological confirmation". The definition of **metrological confirmation** in FDIS ISO 10012 is as follows:

Set of operations required to ensure that measuring equipment conforms to the requirements for its intended use.

Notes

1) Metrological confirmation generally includes calibration, any necessary adjustment or repair, subsequent recalibration, comparison with the metrological requirements for the intended use of the equipment, as well as any required sealing and labeling.
2) Metrological confirmation is not achieved until and unless the fitness of the measuring equipment for the intended use has been demonstrated and documented.
3) The requirements for intended use include such considerations as range, resolution, maximum permissible errors, etc.
4) Metrological confirmation requirements are usually distinct from and are not specified in product requirements.

As ISO 10012 is widely accepted in industry, metrological confirmation is more and more familiar to us. It is used in the management of industrial metrology and guarantees correctness of use of instruments in industrial metrology, just as verification is used in legal metrology.

3 The relationship between calibration, verification and metrological confirmation

From the above discussion, we can show the relationship between calibration, verification and metrological confirmation as in Fig. 1 (see page 22).

Summary

Calibration, verification and metrological confirmation are the important terms in metrology. Calibration is one of the basic elements and forms the technical basis for verification and metrological confirmation, guaranteeing traceability and measurement results both in legal and industrial metrology. Either in industrial metrology or in legal metrology, it must follow the same principle. For example, in order to guarantee the correctness of the verification result, the uncertainty of verification must be less than one third of the maximum permissible error of the instrument verified. The same applies to the uncertainty of calibration, which must be less than one third of the tolerance of the instrument calibrated if one wishes to achieve a 99.7 % confidence level. Compared with metrological confirmation, verification adds some legal requirements to the instrument in order to protect the interest of customers, safeguard the environment, and increase safety. For example, it is necessary to add some legal requirements such as measures designed to protect against fraud, etc., when a flow meter is used as a gasoline dispenser. On the other hand, it is unnecessary to add this kind of legal requirement for flow meters used in industry. ■

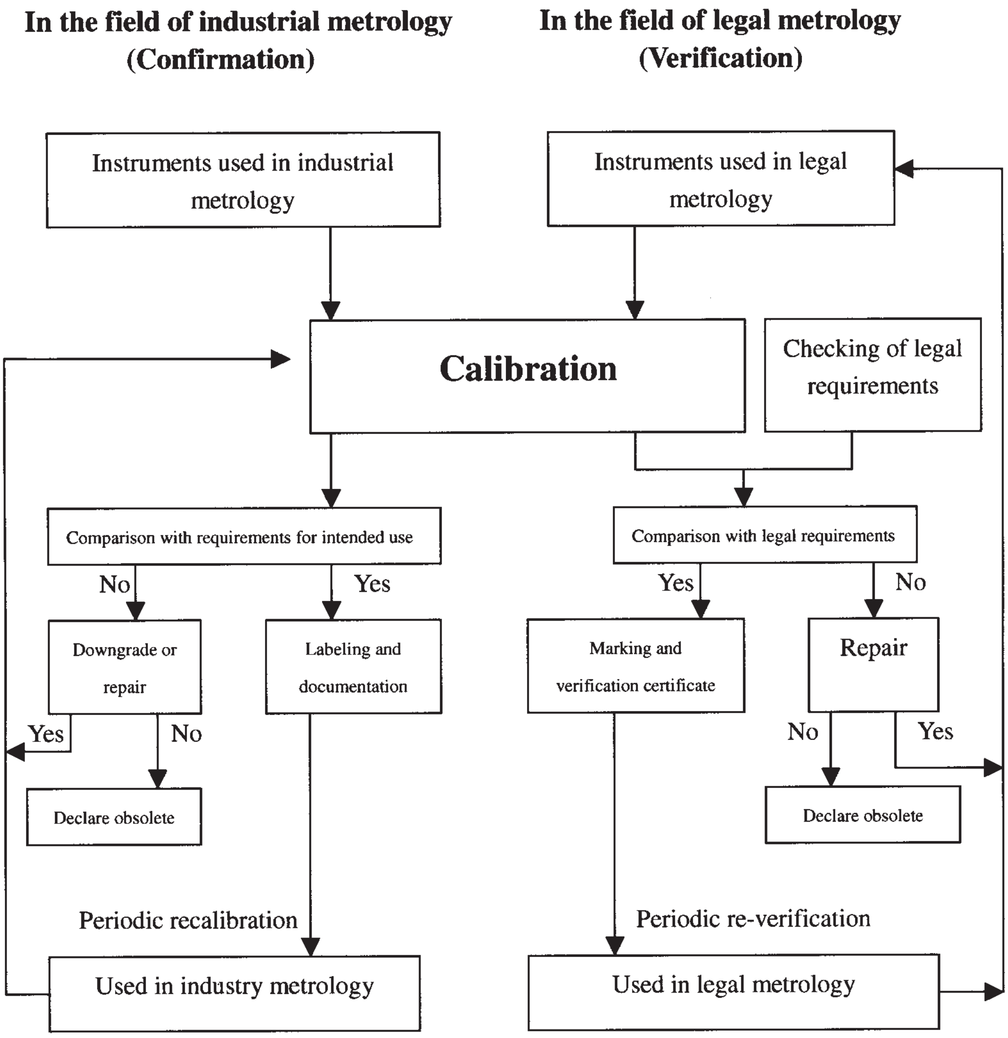

Fig. 1

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The expanding scope of legal metrology and the changing role of the state in a globalised world

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Introduction

Legal metrology developed over 5 000 years ago with the development of civilizations which required consistency of a wide range of measurements used in everyday life. The relationship between the State and metrology was symbiotic. The State needed the information provided by measurements to be able to organise, plan, defend and tax with efficiency. Such accounting depended on uniform measurements that could be aggregated across wide geographical areas and across a broad spectrum of farming and manufacturing practices and work organisation. Metrology on the other hand required the mandate of the State to ensure consistency of measurements.

As well as being a user of metrology the State was also required to provide the necessary trust and confidence in measurement by mandatory standards and requirements. This ensured the integrity of commerce and was realised by the State enforcing measurement standards and requirements and controlling fraud to underpin market transactions.

What is clear from the history of metrology is that its development was driven by a need of the State for information. Where the State was strong the need was greatest and there was a strong commitment to the metrology system. As the State declined metrology declined with it and over the centuries the national metrology systems have ebbed and flowed with the power of the State. In recent years a number of governments in developed countries have reduced their commitment to their metrology system and placed greater reliance on the market to resolve measurement disputes. However the World Bank in its 1997 World Development Report on "The State in a Changing World" [3] noted "an effective State is vital for the provision of the rules and institutions that allow markets to flourish. Without it sustainable development both economic and social is impossible".

The expanding scope of metrology

The past three hundred years has seen a massive transformation of society resulting from the agricultural, industrial, demographic and urbanization revolutions and, particularly for trade measurement, the transport revolution, which transformed local markets into national markets and national markets into international markets. All of these influences greatly expanded the scope of legal metrology.

Weights and Measures originally developed to control direct transactions of the sale of food by quantity between producer and consumer was challenged by a multiplicity of transactions through production, wholesaling, processing and retail trade, at each stage of which measurements were central to the transaction and the range of commodities dealt in expanded with the increasing wealth of society. In addition quality measurements which determined unit price became an important component of the transaction. The establishment of State water gas electricity and telephone utilities added a further layer of trade measurement transactions as did the provision of a wide range of services charged on the basis of measurement such as postal services and freight. Finally globalisation has greatly expanded the application of trade metrology in the international market place.

More recently governments have made increasing use of measurements for the regulation of a wide range of environmental and resource control, health and safety and medical measurements. Because of the objective nature of measurements there tends to be a higher degree of confidence in such regulation compared to using more subjective criteria.

Whilst the expanded scope of legal metrology is impressive its development has occurred in a piece meal fashion and has generally lacked legislative and administrative coherence and co-ordination. The issues are many and include:

1) During the industrial revolution craft based measurement systems developed with units of measurement devised for specific applications. Many of these units are still in use in industry transactions, but have not been incorporated into national measurement systems and rely upon industry standards and traceability.
2) Weights and Measures in many countries has limited its scope to consumer protection. This again has encouraged the development of industry standards and contractual arrangements which are often neither fair or transparent and lead to significant disputation and transaction costs.
3) Weights and Measures has also tended to limit its activities to the control of measurements used for transactions within its jurisdiction. As a result measurement used for

international trade are often not controlled by the trade measurement authority, leading to practices in international trade that would be regarded as inadequate for trade measurement. This jurisdictional issue is a significant challenge to establishing a global legal metrology system that will have a similar degree of trust and confidence to that which exists in national systems. However the legal structures and institutions that provide the trust at a national level do not exist at the international level.

4) Weights and Measures systems were traditionally based on the control of quantity and many authorities have been reluctant to expand the scope of their activities to control quality measures
5) The fundamental basis of a metrology system is that measurements are derived from a common standard with a stated uncertainty. However many nations have not provided a legislated definition of traceability leading to doubts about the legal standing of national standards of measurement and difficulties in establishing a sound evidential basis for measurements that are carried out for legal purposes.
6) Government regulations using metrological requirements have usually been developed by the Department responsible for the regulation and quite often without any discussion with the national legal metrology authority or reference to existing metrology legislation. The problems associated with this lack of co-ordination was highlighted in a paper by Dr Mc Croubey of NBS on the future of Legal Metrology in the USA published in the OIML Bulletin in 1980, in which he said:

    "Our capabilities at all levels of government for providing a basis for adequate measurement accuracy in these new and important areas falls short of the legislated mandate. In fact, our institutionalised metrology services do not extend into these areas to a sufficient degree."

7) The resolution of these issues has been further complicated by government policies on deregulation, privatisation and competitive markets. There is too often a lack of recognition among economists that a key role of metrology is to facilitate markets, and deregulation and competitive markets will have a greater need for measurement.

The concept of a national measurement system was developed in the 1960's and was important for its systems approach that gave coherence to the vast range of technical activities that comprise the system. The development of the SI system of units provided a focus for this coherence but as indicated above there is still a high degree of fragmentation in the system.

The role of the State

The twentieth century was remarkable for a massive expansion in the science and technology of measurement, but at the same time a high degree of fragmentation both institutionally and sectorially, and a lack of development of metrology legislation. This is partly explainable by the existing Weights and Measures legislation not being able to encompass the expanding scope of legal metrology, but acting as a legislative and administrative impediment to the development of appropriate legislation

An important role of legislation is to define the commitment of government, and generally the commitment has not kept up with the development of metrology and its contribution to trade and commerce, industrial development, effective government regulation and its use in a wide range of community activities. Unfortunately this lack of commitment is now being displayed in a decline in government funding for metrology.

Globalisation

Globalisation poses a number of questions for national metrology systems viz:

i) where traceability is required to national standards what is the legal standing of measurements that are traceable to other national standards?
ii) what is the legal standing of "overseas" calibration certificates?
iii) what are the legal difficulties in accepting and using "overseas" test reports?

With regard to (i) and (ii) the answer will depend on national law but generally there are likely to be evidential problems where traceability has been defined in legislation in terms of national standards. Where such a definition in legislation doesn't exist it would be a matter for the Courts to decide.

One way of overcoming these difficulties would be to have legal traceability requirements in terms of both national standards and equivalent standards as determined by the BIPM Equivalence Agreement. However this would probably require the Agreement to have some international legal standing eg a Treaty.

With regard to (iii) depending on how the metrology legislation is worded there should be no legal impediment to a National Pattern Approval Certifying Authority accepting and using "overseas" test reports for issuing national pattern approval certificates however the Authority would then accept any legal liability arising from such use.

From the above analysis it is clear that the future of metrology is strongly dependent on re-establishing the commitment of the State to this essential activity. This will be achieved on a firm and continuing basis by modernisation of national metrology legislation to establish the commitment of government to the national measurement system and providing a sound evidential basis for all measurements that are used for any legal purpose. A key element of such legislation would be an internationally harmonised definition of traceability and provisions for certification of measurements which would be acceptable in a global measurement system. ■

Opportunities and future trends in legal metrology control of measuring instruments

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Introduction

Currently, legal metrology control generally includes type evaluation and approval, and initial and subsequent verification. In the future, one can envision legal metrology control to also include:

- quality management systems for the production of instruments and the manufacturer's declaration of conformance of the individual instruments to the requirements of initial verification,
- subsequent verification of measuring instruments carried out in a manner to provide 'market surveillance', and
- exchange of field test information among nations that have established mutual acceptance arrangements with regard to 'type evaluation'.

This future will require oversight by 'national responsible officials' - legal metrology services - to ensure the competence of instrument manufacturers as well as that of participants and partners in the mutual acceptance arrangements. For maximum effectiveness, these processes should be implemented on a global basis. Thus, the OIML is expected to lead and play an important, essential role.

Legal metrological control procedures

For measuring instruments, the following procedures apply:

- Type evaluation and approval:
  - testing laboratories
  - certification bodies (issuing authorities)
- Initial verification:
  - field officials
  - manufacturer's declaration
- Subsequent verification:
  - field officials
  - readjustment (calibration)
  - maintenance and repair
- Market surveillance:
  - individual instrument failures identified, recorded and notified
  - recall of instrument types displaying a record of failures
  - requires manufacturers to implement adjustments in the field or in production

Current and past practices

A view of the future reflects what is happening currently and what has happened in the recent past. The principles of determining the competence of calibration and testing bodies were beginning to be discussed about two decades ago and have been implemented at least during the last decade along with determining the competence of certifying bodies. These principles are being applied broadly. Out of these developments, the *OIML Certificate System for Measuring Instruments* was developed.

The *OIML Certificate System* has been a huge success since it was initiated in 1991. The challenge will now be to complete and initiate the MAA and to revise OIML D 19 on type evaluation and approval and D 20 on initial and subsequent verification, along with developing an OIML program for certifying individual instruments. The basic tools necessary for accomplishing these tasks are in place.

An OIML Technical Subcommittee TC 3/SC 5 on 'Conformity assessment' was established in 1999 under TC 3 'Metrological control' that has responsibility for the project for developing the framework for a mutual acceptance arrangement on OIML type evaluation (MAA).

The output from the various OIML Technical Committees on specific Recommendations and the guidance documents on metrological control are expected to provide a firm basis for global implementation and harmonization of national regulations.

Recommendations pertain mainly to type evaluation[1] and incorporate the following principles providing a means for type approval and certification:

a) Metrological requirements:

- Accuracy class
- Maximum permissible errors
  - rated operating conditions, reference conditions
  - rated operating conditions, with influence factors
- Influence factors
  - climatic (temperature, humidity, etc.)
  - mechanical
  - electromagnetic
- Repeatability and reproducibility
- Discrimination and sensitivity
- Reliability over time
- Mutual recognition and acceptance arrangements

b) Technical requirements

- Indication of the results
- Software
- Markings
- Operating instructions
- Suitability for use

c) Test program and procedures

d) Format of the test report

e) Certification or declaration of conformity

Mutual recognition and acceptance arrangements

Another significant development in the past decade has been the mutual acceptance arrangement being carried out under the Treaty of the Metre which focuses on physical standards and calibrations. The successful implementation of this MRA that addresses the 'equivalence' of national physical standards could provide the necessary confidence in the 'traceability' of calibrations and measurement results. It would support OIML activities related to unifying and harmonizing the metrological control of measuring instruments globally.

The basis of these mutual arrangements and oversight functions will be the principles of determining competence that have been developed in international standardization bodies such as ISO and the IEC and member organizations. Such principles are contained in ISO/IEC Standard 17025 for calibration and testing laboratories and in ISO/IEC Guide 65 for certifying bodies. Competence of such bodies can be carried out by assessments, by accreditation bodies, or by peer assessment. That is:

- Bodies involved:
  - Issuing authorities
  - Testing laboratories
- Methods of assessment:
  - Accreditation
  - Peer assessment
- Considerations:
  - Availability of complete testing facilities
  - Qualified personnel
  - Training
  - Cost
  - Financial and human resources

It will be necessary for the OIML to incorporate such principles in those Documents directed towards national, regional, and international harmonization of legal metrological control of measuring instruments.

Experience has shown that such principles will need to be updated and revised on a periodic basis. Thus, it will also be necessary to revise accordingly those Documents for which such principles have been adopted in Documents for international application such as fields of legal metrology.

The principles that should be observed by international standards bodies in the development of their projects are as follows:

Transparency – all essential information available to interested parties.

Openness – participation open on a non-discriminatory basis.

Impartiality and consensus – consider all views and attempt to resolve differences.

Effectiveness and relevance – respond to needs and performance rather than design based to promote development.

Coherence – avoid duplication and establish cooperation with relevant work of others.

Development dimension – consider the needs of developing countries.

[1] BIML Note: Most OIML Recommendations pertain also to verification, since initial and/or subsequent verifications belong to legal metrology activity and are thus subject to national or regional regulations.

Future trends

The principles of a 'Framework for mutual acceptance arrangement on OIML type evaluation' (MAA) are in the process of being finalized. Much has yet to be learned after the approval and implementation of the MAA. Based on the experience gained in its implementation, the MAA will require continued development and maintenance.

In the harmonization of metrological requirements in mutual arrangements for type evaluation, agreement will need to be established on metrological and technical performance requirements, examination and testing procedures, and the format of the test report. For metrological requirements, agreement should be reached on accuracy classes, maximum permissible errors under rated operating conditions at reference conditions and under applicable influence quantities. For technical requirements, agreement should be on features necessary for the instrument to perform correctly and display accurately and should also include labeling, except for some specialized national and regional requirements.

Trends in the field of verification are expected to include the use of remote monitoring of measuring instruments in service. The use of Internet services should facilitate much of this monitoring. However, local radio-wave devices may also be employed. Software specific to operating such services should also be available.

Future opportunities

A future challenge based on the experience gained in the implementation of the MAA will be the development of an 'OIML certification program for individual measuring instruments'. Such a program will have as its basis the existing principles provided in OIML D 27 on initial verification based on the manufacturer's quality management system.

The benefits of these efforts will be to facilitate the marketing of 'type approved' measuring instruments for carrying out measurements under legal metrological control globally. The areas affected will be equity in trade of the quantity of products, the protection of public health and worker safety, and the monitoring and protection of the environment. These efforts will provide protection of the consumer and establish broad confidence in the quantity and quality of goods and services.

The areas of legal metrology control of instruments may be summarized as follows:

- Equity in the quantity or quality of products marketed:
  - buyer and seller
  - consumers of products
  - labeling of quantities of products in packages
- Public and worker health and safety:
  - medical diagnostic instruments
  - clinical instruments used in analysis
  - monitoring of workers' exposure to potential harmful conditions
  - monitoring of the workplace environment
- Environment:
  - monitoring pollutants in the air, water, and soil
  - determining the level of pollutants (contaminates) in food products
  - verifying and maintaining analytical instruments used for analysis

Conclusions

Future developments in legal metrology control of measuring instruments will depend on the application of the principles laid down in significant publications.

Some of those publications that include vocabularies, requirements for competence for testing and calibration laboratories, requirements for bodies operating certification systems, quality management systems, type approval, initial and subsequent verification, and the framework for a mutual acceptance arrangement for type evaluation are as follows:

International vocabulary of terms in legal metrology (VIML) - OIML, 2000

International vocabulary of basic and general terms in metrology (VIM)
BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 1993

ISO/IEC Guide 2, 1996
Standardization and related activities – General vocabulary

ISO/IEC Guide 17025, 1999
General requirements for the competence of testing and calibration laboratories

ISO/IEC Guide 65, 1996
General requirements for bodies operating product certification systems

ISO/IEC CD 17040, 2001
General requirements for peer assessment of conformity assessment bodies

ILAC-G10, 1996
Harmonized procedures for surveillance and reassessment of accredited laboratories

ISO 9000 Series
Quality management systems

OIML D 19, 1988
Pattern evaluation and pattern approval

OIML D 20, 1988
Initial and subsequent verification of measuring instruments and processes

OIML D 27, 2001
Initial verification of measuring instruments utilizing the manufacturer's quality system

OIML P 1, 2003
OIML Certificate System for Measuring Instruments

OIML Draft Document
Framework for a mutual acceptance arrangement for OIML type evaluation (MAA)

OIML Draft Document
Checklists used by issuing authorities and testing laboratories involved in type evaluation

Measuring instrument technology and customers and contractors of legal metrology in the mid 21st century

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This presentation relates to what will doubtless be new territory for the OIML in 2020.

Let us first briefly consider the relationship between metrology and the activity of society's economic players (individuals, industry, associations), who each have their own strategies. Metrology plays an important role, since measurement results allow evaluation. Then the players predict, and play according to their predictions. The results of their actions will be applied again to the measurements which become optimized, and this sequence continues for as long as the players continue to play in the economy.

It is true that metrology is one of the most important techno-infrastructures for the intellectual activity of the economy, and broadens the individual activity of the players.

The increase in benefit for the economy, measured by the increase in GNP for example, is limited when the players play independently. But once they are all tuned in to the techno-infrastructure together, their roles take on similar directions and total economic productivity increases.

As the economy grows, both the cost and speed of supply of the techno-infrastructure become more and more important and its dependability, reliability or uncertainty for example, should be dependent on the cost the players can afford and the speed at which they can play. This will be true for metrology too, and it is useful to study this techno-infrastructure concept in more depth.

It must be systematized for easy access of each player, for flexibility in reacting to economic changes, for development and for maintenance, and systematization must be coordinated by legislation or formal regulations.

Metrology has a special place among many other techno-infrastructures and consists of measurement standards and legal metrology. Besides metrology, we have another techno-infrastructure related to database and evaluation methods. The object of database and evaluation methods may be subject to economic policy. In the Japanese case, geological, biological and chemical objects - and the quality of life - are regarded as being of importance because of the recent disasters in these fields from which we have suffered.

What will the economy in the 21st century look like? Globalization can be described as "global dependability". Non profit-making organizations will contribute to the economy and new measures such as those designed to enhance the quality of life, should be applied for the benefit of the economy.

The Japanese economy can be taken as an example. A player, in this case an industry, needed its own cooperating industry to supply raw materials and services. The cooperating industry needed other cooperating industries and eventually, many industries were involved in the activity of the first one. This arrangement worked well until the main banks started intervening. In order to pursue successful production, each group constructed its own independent techno-infrastructure. Then there were over 100 groups in our economy and, hence, 100 independent techno-infrastructures. And then the economy became corrupt and simultaneously national security was violated. With this, the Government started to devise a structure for its techno-infrastructure and reformed the institutes. A new Government department was set up with an office of weights and measures for legal metrology and the institutions were reorganized, the idea being to provide the players with well-coordinated techno-infrastructures (it should be noted that the new division is in charge of ensuring the coordination of the entire national R&D program from the view point of developing the techno-infrastructure). With it, all the economic players contribute coherently for the benefit of the economy.

Above all, the national metrology system will play the basic and key role in the program, and then the players must enjoy free choice as far as the dependability, cost and delivery time are concerned.

Now let us consider the main subject pertaining to the relationship between new technologies and legal metrology in 2020.

The basic idea is the following: society in 2020 will still have both an existing economy and also R&D for advanced technology, which is "fuelled" by the economy. These will yield products, such as new tools and instruments both for accelerating development and for creating a new social system. The economy will evolve and its metrological needs will change. Certainly, new metrology will benefit from new technology. The new social system and new metrology will be the contractors of legal metrology.

The author points out three examples of new technology (from among many other fields) with which readers will already be familiar: information technology, environmental technology and biotechnology.

Information technology provides many other technologies with economies of scale and faster processing speeds. Typical products are telecommunications media, miniaturized devices, large-screen displays, wearable computing elements, or robotics with integrated sensors. It can be noted that current information technology appears to be focused on the human interface. Besides hardware technology, information processing technology enables us to design intelligent devices such as electronic signature and security features.

As for environmental technology, new technology takes care of weather forecasting, the ocean or pollution; the special feature of this technology will be to deal with complex multi-component systems within global environmental technologies, and simulation technologies ranging from nanoscopic to gigascopic scales.

In the biotechnology field, much innovative R&D is ongoing in such fields as gene technology, directly influencing the quality of life, including DNA appraisal for both humans and whales. Specific metrological issues arise particularly in this field: for example the systematization of metrology, the establishment of measurement traceability, and the certification of measuring instruments.

The author gives typical examples of new technology products, probably requiring changes in metrology: intelligent mobile phones incorporating sensor systems, wearable computers, robots, DNA chips, or micro chips for micro totalizing analytical systems, which consist of tiny manifold systems and multi-sensor systems; the fluid specimen is analyzed chemically and the results are fed into the computer.

Before discussing what possible future implications these new R&D products will have on metrology, the author first describes those arising from the normal evolution of the economy itself.

Conventional metrology was supported for its features such as mass production and harmonized instructions for the use of products, and measurements were mainly intended to ensure quality control for the uniformity and stability of production.

Since the new economy will be based on such features as high value added product, market research, short technology life cycle and a wide product range, new metrology must meet these requirements in terms of cost, time and dependability. Attention must also be paid to global production and marketing systems, deregulation, and flexible certification for personal activity.

Now the metrological needs originating from such new technology can be discussed.

Conventional metrology involved the application of objects to measuring instruments, measuring instruments themselves, their operation, and the display and transmission of the measurement data.

But new technology requires metrology to cover other processes in the players' activity such as evaluation, prediction and action:

- Calibration for new sensing systems (micro TAS - Total Analytical Systems);
- Verification of software;
- Immediate certification of the measurement and the evaluation;
- Certification of a number of measurements;
- Rapid modification of measurement functions; and
- Systematic certification of modular measuring instruments, families of measuring instruments, and system measuring instruments.

The provisions made available by these new technologies also have to be discussed.

Chip sensors in measuring instruments allow self-diagnosis of the instruments and enable their individual history to be recorded. Evidence supporting the enforcement of verification, calibration and maintenance can also be transmitted accurately and in a timely manner. Database technology will additionally permit the automatic registration of measuring instruments, and will allow their performance to be diagnosed and their status reported on.

Software verification will use technical requirements as a reference. There are many gaps between "natural" language and artificial software languages and this process is irreversible, making it difficult to verify software. If development and verification are coordinated, then the process will become much easier.

Artificial intelligence may provide the following improvements concerning metrology:

- Systematic software verification;
- Technical requirements described not by their character, but by video and audio media, which will enable quick and remote certification and surveillance;
- Systematic semantic analysis of "natural" language and software language descriptions concerning technical requirements;
- Artificial intelligence appraisal will contribute to the impartial coexistence of certification and the production of measuring instruments or measurements themselves;

- Simulation technology will improve both the precision and speed of pattern evaluation; and
- Robotics and e-measurements (*measurements based on electronic information technology)* will be useful in avoiding human errors in verification and testing.

If two players are involved in a transaction, they may wish to evaluate each others' products. However, it is difficult for each to evaluate the other alone and the assistance of a consultant might be sought so a transaction occurs between each player and their consultant. This continues until dependability is guaranteed by the authority.

These new recursive certification structures will lead to new certification business, and measurement results must be certified.

The activity of non-profitable organizations must be based on impartial evaluation. Rigid application and high dependability should be taken care of by legal metrology, while flexible and cost-oriented dependability should be taken care of by voluntary certification.

As for the contractor of new metrology, a *global metrology system* should be the ultimate contractor. However, private organizations should be counted among these, if impartiality is guaranteed by new R&D. And the role of the government as a coordinator of legal metrology players is very important.

As a conclusion, the author describes the tasks of a global legal metrology system.

So far, harmonization of technical requirements for measuring instruments has been accomplished in the context of global legal metrology. But in the future, harmonization of measuring instrument control and certification must also be discussed.

The estimation of the costs and fees policy for metrological control and accreditation, together with certification modeling of calibration, testing and supervision, must also be further discussed. ■

The pattern approval process: The past, present and future as seen by US instrument manufacturers

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What will the pattern approval process look like next year or in the year 2020?

Will it be different than it is today?

No one person or individual organization can answer both these questions with guaranteed accuracy, but each of us will agree that it will be different than it is today.

Leaders of the international metrology community who were present as a group at the *2020 Seminar* should be able to, can, and indeed must define the future of the pattern evaluation process and what it should look like. To do this we need to begin now. We need to look at all the hard work that was put into developing the current systems, and also at the efforts that many of the OIML Technical Committees and Subcommittees are making in focusing their work in this direction.

The author spoke at the *2020 Seminar* as a representative of the US Scale Manufacturers' Association, the objective of which, as manufacturers, is not to undermine the approval process, but rather to streamline it; not to ask for easier standards but to work towards developing strong global standards. The Association's goal is no different to that of manufacturers of any other product: to bring high quality, cost effective products, using new technology, to the marketplace faster with no breach of any legal requirements and with a minimum consumption of natural resources.

Those that attended must work together to define what legal metrology will look like in the year 2020, to define the efforts needed to reach these goals, and begin working on them today. The most effective way to accomplish this is to look at where we were before, compared to where we are today. We need to identify our successes and our failures and learn from both. We need to look at the needs of our customers and work together to meet them.

Beginning in the 1960's and continuing into the 1980's, individual United States weights and measures jurisdictions began to require that manufacturers prequalify their weighing instruments before allowing them to enter their commercial marketplaces. While these early evaluations were relatively informal and rudimentary, they met the needs of the day. In the mid 1980's, with some 15 or 16 individual state jurisdictions requiring certification, the National Conference on Weights and Measures (NCWM), in conjunction with the National Institute of Standards and Technology (NIST), developed the National Type Evaluation Program (NTEP). The program was a national system managed by the National Type Evaluation Committee, which relied on a small network of approved state and federal laboratories. These laboratories conducted instrument evaluations and issued national Certificates of Conformance. Under the leadership of the NCWM, this program continues to grow today with the goal of developing common technical requirements designed to meet global product needs.

The author gave an example of how two different members of the metrology community have worked together to achieve a common goal, and one which did not compromise any existing technical or legal requirements associated with either country's metrology requirements.

By the early 1990's, the USA had a well-established evaluation program. US manufacturers then looked to expand this program outside national borders. With the NIST taking the lead role, this effort resulted in discussions that led to a bilateral mutual acceptance agreement with Measurement Canada to recognize each other's test data. The program's unique feature was that the US and Canada did not attempt to harmonize their technical requirements; they "simply" reviewed and compared the two sets of technical requirements and agreed to evaluate the instruments to the more stringent requirement. As a part of this process, the laboratories on both sides of the border along with industry experts worked out standardized test procedures to assure uniformity in the end product, the test report. The testing laboratory then shared the results of this evaluation as evidence of compliance. Thus a single test system was developed which provided a single evaluation as the basis for issuing both US and Canadian approval certificates.

Looking back, one can certainly feel a sense of accomplishment; a goal realized. Can we stop here? No! We need to look into the future. We need to set new goals and realize new accomplishments. Everyone has heard the statements "the world is getting smaller" and "the marketplace is more global". That is true: obstacles such as time and distance are a fraction of the inconvenience they were in the past. The obstacles of today are consumption of natural resources, global standards, time to market for new technology, and limited market potential. Products that were once designed and manufactured for a single national market are being replaced with ones that meet the requirements of a global market. As members of the metrology community, we need to think along these same lines.

Some of this is already occurring. The example above of the Canadian and US agreement is an indication of global thinking without compromise to national requirements. Other efforts in this area are the agreement between Australia and New Zealand to accept each other's test data, and the current effort of the OIML on the Mutual Acceptance Arrangement (MAA) designed to permit acceptance of test data on a global level and open to anyone willing to participate.

Mutual acceptance of test data is a positive first step, but it is only the first step. It clearly brings the metrology community and product evaluations to a higher level but it still has many shortfalls. One laboratory is reluctant to accept the test data from another because of a lack of confidence in the other laboratory's abilities. While this is an understandable concern, it causes delays in reaching an acceptance agreement. In an extreme example, the cost involved in showing an acceptable level of confidence may prevent the agreement from ever being realized, and the first step from ever being reached.

Mutual acceptance of test data is a good idea but we must ask ourselves if this approach will ever be the normal mode of operation. Or, will the few examples that currently exist be the exception?

We must also ask ourselves if the evaluation of a single unit conveys satisfactory confidence in the manufacturer's ability to produce additional units to the same performance level as the one unit evaluated. If we have that confidence, then why have initial verification? Type or pattern approval should be enough. If we do not have this confidence then why express so many concerns regarding the confidence in the ability of other laboratories. We should focus on the big picture, i.e. initial verification, since this is where the problems lie.

We should also look to the manufacturer to help in this area. Conformity assurance programs such as the one defined in the NAWI Directive of the European Union and the Conformity Assessment (Production Meets Type) program of the US Scale Manufacturers' Association go a long way in providing confidence in the produced product. More confidence than the evaluation of a single unit built for the reason of type or pattern evaluation.

What are the issues we should be looking at today? How do we adjust today's approval process to overcome today's obstacles while preparing ourselves to address new ones in an effective and timely manner? Some of the author's thoughts are discussed below.

We need to move technical standards to a global level. Some may think this is a large task, though from a technical position it is not. As manufacturers we are already aware of the many different technical standards that exist today. We need to understand the written word and how it applies to our products. We need to understand why the requirements exist so that we can communicate them within our companies. Our experience has shown us that these technical standards have many more similarities than differences. We need to be conscious of our individual and national concerns, but should not use them as a roadblock to a global standard; we should list them along with similar concerns from others and find a common solution. We must also look at the benefits that a global standard will bring.

Common technical requirements will result in fewer interpretation issues. Fewer interpretation issues will result in better educational opportunities.

More education results in a higher level of product compliance during the evaluation process and initial verification.

Develop a seamless approval system. A single manufacturer spends a lot of time, money, and resources to obtain all the approvals necessary to place his product on major markets. If we add together all the manufacturers' approval efforts we soon see that large amounts of each are spent. For example, if a manufacturer's goal is to place a product onto the global market he can be assured that at least two, and maybe as many as five, different approval organizations will be testing his product. To get his product to the marketplace in a timely manner means that at least two to five samples will be sent to various evaluation agencies. Each of these samples will undergo evaluation to very similar requirements. This adds cost to the product, delays introduction to local markets and wastes resources. We must ask ourselves why?

As mentioned before, we need to be aware of our individual and national concerns, but should not use them as a roadblock to a seamless approval system. We must also look at the benefits that a seamless system will bring.

Eliminate repeated testing of the same product to reduce cost, time to market, and wasted natural resources.

Allow national laboratories to apply knowledge to the initial verification procedures and market surveillance, resulting in increased confidence in production instruments.

New technology can be placed in the marketplace faster by assisting and supporting local industries in maximizing efficiency while minimizing cost, resulting in benefits to the local economy.

Develop an international conformity assurance program. As mentioned earlier, several members of the legal metrology community have developed conformity assurance programs. These programs contain a common theme, and ensure that continued production represents that of the sample evaluated. These efforts should continue, but on a global basis. We should take care not to end up with two, three or five different programs each having similar yet slightly different requirements. This is where we are with type or pattern approval today and this is one of the reasons why the *2020 Seminar* was held. We need to learn from our experiences, and we need to develop a single program that provides benefit to the consumer and not to individual businesses. The benefits of a well-developed conformity assurance program are:

- Increase confidence that manufacturers move away from the "golden unit" used for evaluation;
- Provide performance results to requirements that cannot be obtained during initial verification testing; and
- Improve initial verification compliance.

The world is truly becoming a smaller place; national laws and requirements are being adjusted to fit a more global world. Most of this work is being lead by the higher levels of our governments. As members of the legal metrology community, we can either sit back and wait to be told what our future will look like or we can begin working on it today and feel confident that our efforts are directed to a common and global goal. ■

Measuring instruments invisibly connected

Wim Volmer
NMi Certin B.V., The Netherlands

Based on concrete examples, this presentation outlines some of the possible future problems metrological authorities may face, and opens up discussions.

A conventional measurement system is outlined which may be found in large refineries and chemical plants. For example, a multitude of sensors are mounted in pipelines, and flow computers or indicating devices are connected to these sensors for volume measurement (the primary measurement). Temperature, pressure, density, etc. sensors also calculate the volume under base conditions or the mass. All the flow computers are connected to printers which produce tickets to document the transactions. Generally, all these plants have automated data-collection systems and at the present time, legal metrology is not involved in this area.

Typical characteristics of such conventional systems are that they comprise dedicated components: volume sensors, flow computers, printers, etc. which perform specific tasks in a certain order, and which are well known. Because of that it is possible to make a clear distinction between the legal metrology and non legal metrology parts. Also, such installations have mechanical seals for inspection officers who are required to be on site to perform their inspection, and measurement operations require human intervention. Proof of the transaction is usually in the form of a printed ticket. All dedicated components are connected to one another using cabling (which is often as expensive as the instrument itself).

Let us now look at some of the characteristics which may form the bases of measurement systems in the future.

Power will be generated locally by the sun or the wind, which will decrease the need for power supply cabling. Cables for communication will no longer be needed because wireless networks will be installed everywhere.

Devices will be less dedicated than in conventional systems. Multi-task PC-based systems will be used for legal and non-legal metrology activities and it will be difficult to make a distinction between legal and non-legal metrology software.

Proof of transactions will probably be available only electronically, via e-mail or SMS messages on mobile phones.

In the future, measurement systems will be built around PC networks, performing many different tasks including weights and measures control software, control settings and control log-files, to highlight human intervention or any alteration of software settings. Neither the weights and measures office nor the customer will be physically connected to the PC system, nor will the various sensors. Communication with both the customer and the weights and measures authorities will be wireless and electronic; this opens the way for weights and measures inspectors to perform inspection from a distance: they can log onto the PC system, check if any settings have been altered, and whether any electronic seals have been broken. With online reference equipment it will even be possible to perform calibration testing at a distance.

Is this science fiction or not? As far back as in 1966, a certain television science fiction series contained gadgets and technologies which were intended to predict those that would be used in the year 2100–2200. Indeed, many of the computer applications imagined in 1966 are already reality.

The future as described in this article is not science fiction, because some of the developments mentioned are already taking place now.

Batteries are improving constantly. Wireless communication is also improving and for new office buildings it is cheaper nowadays to install a wireless network than a cable network. Also, most electronic devices now consume less power; data cables and power cables can be combined, and the performance of solar cells is much more efficient than before.

What problems could legal metrology staff be faced with?

When transmitted through wireless networks which operate via digital communication networks, measurement signals are, by definition, delayed. The instrument receives the signals, makes calculations and then sends the data to the central PC system.

Software sealing is not yet fully harmonized, and there is at present no clear distinction between legal metrology and non-legal metrology software.

Because of the development of multi-functional devices, huge amounts of software may be involved in a whole system and it would be helpful to know which small part performs the legal metrology operation.

How will we handle the electronic proof of the transaction, if it is transmitted via email or SMS message to a mobile phone?

With the exception of the initial analog to digital conversion inside the instrument, all the measurement characteristics will be determined by the software. The performance of the measuring instrument, if this can still be defined, will be far less dependent on hardware than it used to be and one will have a kind of approval document with requirements to ensure guaranteed operation such as which software and which PC-based operating system are used, and whether the PC in question has at least 128 Mb of RAM for example.

In view of the increasingly widespread use of software as opposed to hardware, will this tendency present specific problems to legal metrology professionals?

As approval authorities or certification bodies, we need to offer some form of guarantee as to the accuracy of the measurements and the data processing after the approval of the transaction. We need to have confidence in the measurement itself and in the recording of the transaction.

But we do have some technological features which will help us. The instruments can be identified using electronic addresses so one knows which kind of device one is looking for.

Software modules can still be identified individually and each module may have a check-sum protection so that one can verify that it is still intact, and that it is in fact the same module that was checked say one month ago. Log files store data, and can be used as evidence that the settings or measurement results have (or have not) been altered. By their very nature, digital communications may always be checked, so we do have some technological means to help us.

Weights and measures problems can be solved by technological means, but we will need to invest in knowledge of these new technologies; international harmonization on, for example, software sealing, will also be required in order to arrive at a solution to these problems. ■

OIML Certificate System:

Certificates registered 2003.08–2003.10

Up to date information (including P1): www.oiml.org

The *OIML Certificate System for Measuring Instruments* was introduced in 1991 to facilitate administrative procedures and lower costs associated with the international trade of measuring instruments subject to legal requirements.

The System provides the possibility for a manufacturer to obtain an OIML Certificate and a test report indicating that a given instrument pattern complies with the requirements of relevant OIML International Recommendations.

Certificates are delivered by OIML Member States that have established one or several Issuing Authorities responsible for processing applications by manufacturers wishing to have their instrument patterns certified.

The rules and conditions for the application, issuing and use of OIML Certificates are included in the 2003 edition of OIML P 1 *OIML Certificate System for Measuring Instruments.*

OIML Certificates are accepted by national metrology services on a voluntary basis, and as the climate for mutual confidence and recognition of test results develops between OIML Members, the OIML Certificate System serves to simplify the pattern approval process for manufacturers and metrology authorities by eliminating costly duplication of application and test procedures. ■

This list is classified by Issuing Authority; updated information on these Authorities may be obtained from the BIML.

Cette liste est classée par Autorité de délivrance; les informations à jour relatives à ces Autorités sont disponibles auprès du BIML.

▶ Issuing Authority / *Autorité de délivrance*

Netherlands Measurement Institute (NMi)
Certin B.V., The Netherlands

R60/2000-NL1-02.02
Type 0765 (Class C)
Mettler-Toledo Inc., 150 Accurate Way,
Inman, SC 29349, USA

For each Member State, certificates are numbered in the order of their issue (renumbered annually).

Pour chaque État Membre, les certificats sont numérotés par ordre de délivrance (cette numérotation est annuelle).

OIML Recommendation applicable within the System / Year of publication

Recommandation OIML applicable dans le cadre du Système / Année d'édition

The code (ISO) of the Member State in which the certificate was issued, with the Issuing Authority's serial number in that Member State.

Le code (ISO) indicatif de l'État Membre ayant délivré le certificat, avec le numéro de série de l'Autorité de Délivrance dans cet État Membre.

Year of issue
Année de délivrance

Certified pattern(s)
Modèle(s) certifié(s)

Applicant
Demandeur

Système de Certificats OIML:

Certificats enregistrés 2003.08–2003.10

Informations à jour (y compris le P1): www.oiml.org

Le *Système de Certificats OIML pour les Instruments de Mesure* a été introduit en 1991 afin de faciliter les procédures administratives et d'abaisser les coûts liés au commerce international des instruments de mesure soumis aux exigences légales.

Le Système permet à un constructeur d'obtenir un certificat OIML et un rapport d'essai indiquant qu'un modèle d'instrument satisfait aux exigences des Recommandations OIML applicables.

Les certificats sont délivrés par les États Membres de l'OIML, qui ont établi une ou plusieurs autorités de délivrance responsables du traitement des demandes présentées par des constructeurs souhaitant voir certifier leurs modèles d'instruments.

Les règles et conditions pour la demande, la délivrance et l'utilisation de Certificats OIML sont définies dans l'édition 2003 de la Publication P 1 *Système de Certificats OIML pour les Instruments de Mesure.*

Les services nationaux de métrologie légale peuvent accepter les certificats sur une base volontaire; avec le développement entre Membres OIML d'un climat de confiance mutuelle et de reconnaissance des résultats d'essais, le Système simplifie les processus d'approbation de modèle pour les constructeurs et les autorités métrologiques par l'élimination des répétitions coûteuses dans les procédures de demande et d'essai. ■

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic catchweighing instruments
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique

R 51 (1996)

Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R51/1996-DE1-03.01
ScanCheck RF5 50XX.YY for accuracy classes X(1) and Y(a)
Scanvaegt International A/S, P.O. Pedersens Vej 18, DK-8200 Aarhus N, Denmark

R51/1996-DE1-03.07
Ventocheck for accuracy class X(1)
Ventomatic SPA, Via G. Marconi 20, 24030 Valbrembo (Bergamo), Italy

R51/1996-DE1-03.09
S 30 278x for accuracy classes X(1) and Y(a)
Soehnle-Waagen GmbH + Co., Wilhelm-Soehnle-Straße 2, D-71540 Murrhardt, Germany

R51/1996-DE1-03.10
PAW 2000-H for accuracy classes X(1) and Y(a)
LEICH+MEHL+Co., GmbH Porschestrasse 7, D-71394 Kernen-Rommelshausen, Germany

R51/1996-DE1-03.11
Types ES 6xyz / ES 7xyz for accuracy classes X(0.5), X(1) and Y(a)
Espera-Werke GmbH, Moltkestr. 17-33, D-47058 Duisburg, Germany

Issuing Authority / *Autorité de délivrance*

National Weights and Measures Laboratory (NWML), United Kingdom

R51/1996-GB1-03.01
WPL-5000 for accuracy classes X(1) and Y(a)
Ishida Co., Ltd. 44, Sanno-cho, Shogoin Sakyo-ku, Kyoto-city 606-8392, Japan

Issuing Authority / *Autorité de délivrance*

Netherlands Measurement Institute (NMi) Certin B.V., The Netherlands

R51/1996-NL1-03.01
BF 2D for accuracy classes X(1) and Y(a)
Garvens Automation GmbH, Kampstrasse 7, D-31180 Giesen, Germany

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Metrological regulation for load cells (applicable to analog and/or digital load cells)
Réglementation métrologique des cellules de pesée (applicable aux cellules de pesée à affichage analogique et/ou numérique)

R 60 (2000)

Issuing Authority / *Autorité de délivrance*
OIML Chinese Secretariat,
State General Administration for Quality Supervision and Inspection and Quarantine (AQSIQ), China

R60/2000-CN1-03.03
SB (Class C3)
Keli Sensor Manufacturing (Ningbo) Co. Ltd., No. 181, Canghai Road, Hi-Tech Industrial Park, Nongbo City 315040, P.R. China

Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R60/2000-DE1-03.05
Type 640 (Class C3)
Revere Transducers Europe BV, Ramshoorn 7, NL-4824 AG Breda, The Netherlands

Issuing Authority / *Autorité de délivrance*
DANAK The Danish Accreditation and Metrology Fund, Denmark

R60/2000-DK1-03.03
SSB-PIAB-R2 (Class C)
PIAB Sweden AB, SE-18422 Akersberga, Sweden

▶ Issuing Authority / *Autorité de délivrance*

Centro Español de Metrologia, Spain

R60/2000-ES1-03.03

TPP-3 (Class C)

Transdutec S.A., C/ Joan Miró 11,
08930 Sant Adrià de Besós, Barcelona, Spain

R60/2000-ES1-03.04

TPP-4 (Class C)

Transdutec S.A., C/ Joan Miró 11,
08930 Sant Adrià de Besós, Barcelona, Spain

▶ Issuing Authority / *Autorité de délivrance*

Netherlands Measurement Institute (NMi) Certin B.V., The Netherlands

R60/2000-NL1-03.20

SBH (Class C)

Ohaus Corporation, 19A Chapin Road, Pine Brook,
New Jersey 07058, USA

R60/2000-NL1-03.21

Type 115 (Class C)

Tedea Huntleigh International Ltd., 60 Medinat
Hayehudim, Herzliya 46120, Israel

R60/2000-NL1-03.22

PW18i (Class C)

Hottinger Baldwin Messtechnic Wägetechnik GmbH,
Im Tiefen See 45, D-64293 Darmstadt, Germany

R60/2000-NL1-03.23

FIT .... (Class C)

Hottinger Baldwin Messtechnic Wägetechnik GmbH,
Im Tiefen See 45, D-64293 Darmstadt, Germany

R60/2000-NL1-03.24

SSP1022 (Class C)

Mettler-Toledo (Changzhou) Scale & System Ltd.,
111 Changxi Road, Changzhou, Jiangsu 213001, P.R.
China

R60/2000-NL1-03.25

3510 and 3510 B (Class C)

Vishay Tedea Huntleigh International Ltd., 5a Hatzoran St.,
New Industrial Zone, Netanya 42506, Israel

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic gravimetric filling instruments
Doseuses pondérales à fonctionnement automatique

R 61 (1996)

▶ Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R61/1996-DE1-03.01

SWA2000C Class Ref (0.2)

B+L Industrial Measurements GmbH,
Hans-Bunte-Straße 8-10,
D-69123 Heidelberg, Germany

R61/1996-DE1-03.02

MEC III Class Ref (0.2)

Haver & Boecker, Carl-Haver-Platz, D-59302 Oelde,
Germany

▶ Issuing Authority / *Autorité de délivrance*

Netherlands Measurement Institute (NMi) Certin B.V., The Netherlands

R61/1996-NL1-03.01

ADW-.... Ref, Class X(0.5)

Yamato Scale GmbH, Hanns-Martin-Schleyer Straße 13,
D-47877 Willich, Germany

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Nonautomatic weighing instruments
Instruments de pesage à fonctionnement non automatique

R 76-1 (1992), R 76-2 (1993)

► Issuing Authority / *Autorité de délivrance*
OIML Chinese Secretariat,
State General Administration for Quality Supervision and Inspection and Quarantine (AQSIQ), China

R76/1992-CN1-03.04
SW-2, SW-5, SW10 and SW-20 (Class III)
Shanghai CAS Electronics Co. Ltd, No 448 Maixin Road, Xinqiao Zhen Songjiang Qu, 201612 Shanghai, P.R. China

► Issuing Authority / *Autorité de délivrance*
Physikalisch-Technische Bundesanstalt (PTB), Germany

R76/1992-DE1-00.07 Rev. 1
DX BM 500 (Classes II, III and IIII)
Sartorius A.G., Weender Landstraße 94-108, D-37075 Göttingen, Germany

R76/1992-DE1-00.09 Rev. 6
iso-TEST (Classes I, II, III and IIII)
Sartorius A.G. Weender, Landstraße 94-108, D-37075 Göttingen, Germany

R76/1992-DE1-03.03 Rev. 1
PL...-S (Class II)
Mettler-Toledo A.G., Im Langacher, CH-8606 Greifensee, Switzerland

R76/1992-DE1-03.04
2790 (Classes III and IIII)
Soehnle-Waagen GmbH + Co., Fornsbacher Straße 27-35, D-71540 Murrhardt, Germany

R76/1992-DE1-03.05
BD BP 10, BD BP 200 (classes I and II)
Sartorius A.G. Weender, Landstraße 94-108, D-37075 Göttingen, Germany

R76/1992-DE1-03.06
335x1, 336x1 (classes III and IIII)
Vogel & Halke GmbH & Co., Hammer Steindamm 9-25, D-22089 Hamburg, Germany

► Issuing Authority / *Autorité de délivrance*
DANAK The Danish Accreditation and Metrology Fund, Denmark

R76/1992-DK1-03.03
Scanvaegt System 8400 (Classes III and IIII)
Scanvaegt International A/S, P.O. Pedersens Vej 18, DK-8200 Aarhus N, Denmark

► Issuing Authority / *Autorité de délivrance*
Netherlands Measurement Institute (NMi) Certin B.V., The Netherlands

R76/1992-NL1-03.21
RN20.. / Viva (Class III)
Mettler-Toledo (Changzhou) Scale & System Ltd., 111 Changxi Road, Changzhou, Jiangsu 213001, P.R. China

R76/1992-NL1-03.22
SM-700.. (Class III)
Teraoka Weigh-System PTE LTD, 4 Leng Kee Road, #06-01 SIS Building 159088, Singapore

R76/1992-NL1-03.23
AIN & ABW (Classes III or IIII)
Universal Weight Enterprise Co. Ltd., 2-5 Fl., No. 39 Pao Shing Road, Hsin Tien City, Taipei Hsien 231, Chinese Taipei

R76/1992-NL1-03.24
MP 30 (Class III)
Pitney Bowes Ltd, The Pinnacles, Harlow, Essex CM19 5BD, United Kingdom

R76/1992-NL1-03.25
CT-series (Classes I and II)
Shinko Denshi Co., Ltd, 3-9-11 Yushima Bunkyo-ku, Tokyo 113-0034, Japan

R76/1992-NL1-03.26
Type RM-40.. (Class III)
Shanghai Teraoka Electronic Co., Ltd., Tinglin Industry Developmental Zone, Jinshan District, Shanghai 01505, P.R. China

R76/1992-NL1-03.27
DS-682.. And DS-532.. (Class III)
Shanghai Teraoka Electronic Co., Ltd., Tinglin Industry Developmental Zone, Jinshan District, Shanghai 201505, P.R. China

R76/1992-NL1-03.28
MS 2xxx series (Class III)
Metrologic Instruments Inc., 90 Coles Road, Blackwood, NJ 08012-4683, USA

R76/1992-NL1-03.29
PS-series (Class III)

SNOWREX International Co., Ltd., 2F No. 9, Lane 50 Sec. 3, Nan-Kang Road, Taipei, Chinese Taipei

R76/1992-NL1-03.30
MS2020 (Class III)

Teraoka Seiko Co., Ltd., 13-12 Kugahara, 5-Chome Ohta-ku, Tokyo 146-8580, Japan

R76/1992-NL1-03.31 Rev. 1
Azplus.. / AM.. (Class III)

ADAM Equipment Co. Ltd., Bond Avenue, Denbigh East Industrial Estate, Milton Keynes MK1 1SW, United Kingdom

R76/1992-NL1-03.32
MS-2800 (Class IIII)

Charder Electronic Co., Ltd, 103, Kuo Chung Road, Dah Li City, Taichung Hsien 412, R.O.C., Chinese Taipei

R76/1992-NL1-03.34
WPT 20D (Class III)

Radwag Zaklad Mechaniki, 26-600 Radom ul., Grudniowa 37/39, Poland

R76/1992-NL1-03.35
DS-425.. (Class III)

Shanghai Teraoka Electronic Co., Ltd., Tinglin Industry Developmental Zone, Jinshan District, Shanghai 201505, P.R. China

R76/1992-NL1-03.36
ASTRA-XT or AC-4000.. (Class III)

Ishida Co., Ltd., 44, Sanno-cho, Shogoin Sakyo-ku, Kyoto-city 606-8392, Japan

R76/1992-NL1-03.37
DC-300 (Class III)

Teraoka Seiko Co. Ltd., 13-12 Kugahara, 5-Chome Ohta-ku, Tokyo 146-8580, Japan

R76/1992-NL1-03.38
IPC series (Class III)

Ishida Co. Ltd., 44, Sanno-cho, Shogoin Sakyo-ku, Kyoto-city 606-8392, Japan

R76/1992-NL1-03.40
MNW 20LA (Class III)

ADAM Equipment Co. Ltd., Bond Avenue, Denbigh East Industrial Estate, Milton Keynes MK1 1SW, United Kingdom

R76/1992-NL1-03.41
MS-2400 (Class IIII)

Charder Electronic Co. Ltd., 103, Kuo Chung Road, Dah Li City, Taichung Hsien 412, R.O.C., Chinese Taipei

R76/1992-NL1-03.42
MS-2800 (Class IIII)

Charder Electronic Co. Ltd., 103, Kuo Chung Road, Dah Li City, Taichung Hsien 412, R.O.C., Chinese Taipei

R76/1992-NL1-03.44
Class III

Ishida Co. Ltd., 44, Sanno-cho, Shogoin Sakyo-ku, Kyoto-city 606-8392, Japan

R76/1992-NL1-03.46
RM-40.. (Class III)

Shanghai Teraoka Electronic Co. Ltd., Tinglin Industry Developmental Zone, Jinshan District, Shanghai 201505, P.R. China

R76/1992-NL1-03.47
WAA xxx/C/2 (Class I)

Radwag Zaklad Mechaniki, 26-600 Radom ul., Grudniowa 37/39, Poland

R76/1992-NL1-03.48
AAA xxxLA (Class I)

ADAM Equipment Co. Ltd., Bond Avenue, Denbigh East Industrial Estate, Milton Keynes MK1 1SW, United Kingdom

R76/1992-NL1-03.50
DPS-4600 (Class III)

Teraoka Seiko Co. Ltd., 13-12 Kugahara, 5-Chome Ohta-ku, Tokyo 146-8580, Japan

▶ Issuing Authority / *Autorité de délivrance*

Russian Research Institute for Metrological Service (VNIIMS) of Gosstandart of Russian Federation, Russian Federation

R76/1992-RU1-03.02
Wagon scale (Class III)

JSWMC "TENSO-M" 38, Vokzalnaya str, Kraskovo Lyuberetskii district, Moscow region, 140050, Russia

▶ Issuing Authority / *Autorité de délivrance*

Swedish National Testing and Research Institute AB, Sweden

R76/1992-SE1-03.01
7021 (Class III)

Optiscan Stathmos AB, Renvägen 1, SE-35245 Växjo, Sweden

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic level gauges for measuring the level of liquid in fixed storage tanks
Jaugeurs automatiques pour le mesurage des niveaux de liquide dans les réservoirs de stockage fixes

R 85 (1998)

- Issuing Authority / *Autorité de délivrance*

  Netherlands Measurement Institute (NMi) Certin B.V., The Netherlands

R85/1998-NL1-03.01
971 with antenna F08, S06, S08, S10, S12 or W06 for accuracy class 2
Enraf B.V., Delftechpark 39, NL-2628 XJ Delft, The Netherlands

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic rail-weighbridges
Ponts-bascules ferroviaires à fonctionnement automatique

R 106 (1997)

- Issuing Authority / *Autorité de délivrance*

  Inspecta Oy, Finland

R106/1997-FI1-03.01
TRAPPER (accuracy class 0.2)
Pivotex Oy, Käärmesaarentie 3 B, PL 8, FIN-02161 Espoo, Finland

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Fuel dispensers for motor vehicles
Distributeurs de carburant pour véhicules à moteur

R 117 (1995) + R 118 (1995)

- Issuing Authority / *Autorité de délivrance*

  Netherlands Measurement Institute (NMi) Certin B.V., The Netherlands

R117/1995-NL1-02.01 Rev. 4
model SK700 for accuracy class 0.5
Gilbarco GmbH & Co. KG, Ferdinand-Henze-Straße 9, D-33154 Salzkotten, Germany

R117/1995-NL1-03.01 Rev. 1
model ENCORE for accuracy class 0.5
Gilbarco GmbH & Co. KG, Ferdinand-Henze-Straße 9, D-33154 Salzkotten, Germany

- Issuing Authority / *Autorité de délivrance*

  Russian Research Institute for Metrological Service (VNIIMS) of Gosstandart of Russian Federation, Russian Federation

R117/1995-RU1-03.01
MEB/MPD/MMS for accuracy class 0.5
Mercantile & Industrial Development Company Ltd., 39/44, Scheme 6, Road 2, Sion (East), 400022 Mumbai, India

R117/1995-RU1-03.02
MIDCO for accuracy class 0.5
Mercantile & Industrial Development Company Ltd., 39/44, Scheme 6, Road 2, Sion (East), 400022 Mumbai, India

Updated information on OIML certificates:

www.oiml.org

38 CIML

38th Meeting of the International Committee of Legal Metrology

November 5, 2003

Opening Address

by Mr. Hiroshi Ogawa Director General of Industrial Science & Technology Policy & Environment Bureau (METI)

President Mr. Faber, Ladies and Gentlemen,

It is a great honor for us to welcome you to Kyoto, one of Japan's most historical cities, and to open the Thirty-Eighth Meeting of the International Committee of Legal Metrology.

The year 2003 marks the Hundredth Anniversary of the inauguration of the Central Inspection Institute of Weights and Measures in Japan, which was the first organized attempt to provide modern measurement standards. In this significant year, it gives us great pleasure to host the CIML Meeting for the first time in Japan.

I believe that the main objective of the legal measurement system is not only to provide standards for industry and commerce but also to ensure the accuracy and reliability of transactions around the world. Moreover, the scope of legal metrology is continuously expanding to respond to changing requirements over time. As can be seen from the example of the research topic *Mass Spectrometric Analyses of Biological Macromolecules* chosen by the Nobel Laureate Mr. Koichi Tanaka, who works here in Kyoto, there is no doubt that precise measurement is necessary for environmental protection, health and safety - all of which are areas of great concern to many people.

Along with the currency system, the measurement system is fundamental to economic and social activity, and is the basic system for all aspects of life. In Japan, the first systematic measurement system was introduced in the year 701, modeled on the system in use in China. While refining the unique units of length in Japan, we established a metrology verification system. In response to the rapid globalization of economic transactions, the technical requirements for measuring instruments used in Japan conform to the International Recommendations of the OIML. Whatever the era and the country, determining accurate measurement standards is essential for safeguarding our daily life and improving economic development - and indeed civilization as a whole.

The ever-increasing work carried out by the OIML with the objective of further increasing international cooperation is continuing to harmonize measurements and measurement techniques in a large number of countries, and the Organization continues to play an important role in reducing barriers to trade. This Committee Meeting will serve to review and further develop the OIML's strategy in reaching these objectives.

Japan is well aware of the importance of international contributions in the area of legal metrology and currently holds the presidency of the Asia-Pacific Legal Metrology Forum. We plan to continue our international contributions, including support to developing countries, in the future.

Last but not least, I wish to express my sincere gratitude to the CIML President, Mr. Faber, to all the Members of the CIML, to Mr. Magaña and his staff and also to the many other people involved for their tireless efforts in making this important event become a reality. During this four-day meeting, I sincerely hope that you will share your views on measurement systems in the 21st century, and that you will also enjoy your stay in Kyoto.

Thank you for your kind attention. ■

Left to right: Mr. Ogawa, Dr. Ono and Mr. Faber

38^{th} Meeting of the International Committee of Legal Metrology

November 5, 2003

Opening Address

by Dr. Akira Ono Director National Metrology Institute of Japan (NMIJ)

Mr. Faber, Distinguished Guests, Ladies and Gentlemen,

On behalf of the National Metrology Institute of Japan I would like to welcome you to Kyoto, which as you may know was previously the capital city of Japan.

At the opening of this CIML Meeting, I would like to briefly talk to you about the history of Japanese metrology. In ancient Japan, metrology was first established right here in Kyoto, from where it was disseminated throughout the country over a long period of time. As you are aware, ancient metrology was superseded by modern metrology in 1875 with the establishment of the Metre Convention.

2003 is a special year for Japanese metrology. Just one hundred years ago in 1903, the former NRLM was founded in the new capital city of Japan, Tokyo, and premises were also opened in Osaka. The name of the Institute has since changed several times, but it has continued to play its role and became the National Metrology Institute of Japan, or NMIJ. We are especially pleased to host the CIML Meeting here in Japan in our centenary year.

Legal metrology is now becoming more and more global, and I am well aware that the role of the OIML is increasing year by year. It is very timely for the CIML to discuss the Mutual Acceptance Arrangement in legal metrology, and I am sure that the establishment of the MAA will be a huge step forward in meeting the needs that have been highlighted in view of this modern trend towards globalization. I am sure that the efforts that have been made so far both by yourselves as CIML Members, as well as by your President, Mr. Faber, over the last several years will be confirmed and rewarded as you set out to react to this new challenge.

I hope not only that the Thirty-Eighth CIML Meeting will represent another major step forward towards our goal, but also that you will all enjoy the autumn season in Kyoto, which certainly for me personally is the best season of the year.

Thank you very much. ■

38^{th} Meeting of the International Committee of Legal Metrology

November 5, 2003

Opening Address

by Mr. Gerard Faber CIML President

Ladies and Gentlemen,

It is my pleasure to welcome you to this Thirty-Eighth Meeting of our Committee and I thank you in advance for your participation which, I am sure, will be as positive and fruitful as ever.

This is the first time that we have the privilege of meeting in Japan, and especially in such a beautiful city as Kyoto, with its 1200 years of history. I was lucky to have already had the honor of visiting this wonderful place and the surrounding area, and I have no doubt that delegates will have the opportunity to appreciate the cultural treasures that it offers to us. Holding our Meeting in such a modern and impressive International Conference Center will certainly make our work easier and very productive, and I want to extend my sincere thanks to our Japanese hosts who have gone out of their way to provide such superb facilities.

So according to tradition, I would like to start with some words concerning our new Members.

We have great pleasure in welcoming two new Member States, New Zealand and Vietnam, who have both changed their position from Corresponding Members to full OIML Member States. The OIML now therefore comprises a total of 60 Member States, and this increase in membership shows that our Organization is not only healthy but also that it continues to answer the needs of the international community.

In reviewing the composition of our Committee, I have pleasure in welcoming the following new Members:

For BULGARIA:	Mrs Ani Todorova
For KENYA:	Mr. I.M. Ngatia
For SOUTH AFRICA:	Mr. Stuart H. Carstens
For MACEDONIA:	Mr. Danco Pendovski
For ITALY:	Mrs Daniela Primicerio
For POLAND:	Mrs Barbara Lisowska
For SRI LANKA:	Mr. Upananda Senaratne
For NEW ZEALAND:	Mr. John Barker
For VIETNAM:	*To be advised*

I also welcome one new Corresponding Member, Nicaragua, and additionally those Participants in this meeting who are in the process of becoming officially appointed CIML Members.

Our Meeting this year is one of the most important meetings we have had in recent years.

The OIML is increasingly linked with other international Organizations. I want to mention the work which has started this year concerning assistance to Developing Countries, in a Joint Committee established with all the major Organizations in metrology, accreditation and standardization. I am very pleased to welcome Mr. Buck, from the IEC, with whom we have recently organized some very successful Seminars for Developing Countries, on an initiative of the World Trade Organization.

The issue of Developing Countries will be discussed in this meeting. The Task Group on Developing Countries, which was set up last year, has made a very worthwhile contribution to the Organization. A number of its proposals were included in the ongoing revision of the OIML Action Plan, information on which will be given to you this week, and the Task Group also made recommendations for a revised organization of the work on Developing Countries. These recommendations were discussed at the Development Council Meeting and at the Presidential Council Meeting, and will also be presented to you so that the Bureau can prepare decisions to be submitted to the Conference next year.

The technical work of the Organization over the past year has been quite fruitful and we have a number of technical documents to approve. The progression in our methods of work and in the organization of the Bureau is also advancing and a number of decisions will have to be made and procedures approved. Among them are the new Staff Regulations for the Bureau, and a preliminary paper on the four-year budget, which has to be presented next year at the Conference.

Last, but not least, two essential issues for the future of the OIML are on our agenda.

The Mutual Acceptance Arrangement, which was the object of a very successful meeting in June this year, is now being submitted for your approval. I think that this document now answers the expectations of most Members and can reach the required consensus. I do hope that it will be approved and that we can start implementing it as soon as possible.

The second issue is the election of a CIML President. The OIML will face crucial challenges over the next years in building a global legal metrology system, and the role of the CIML President will be essential.

These are, my dear Colleagues, the major topics that we shall have to examine and/or decide upon during this meeting.

So, at the end of my opening address, may I ask the BIML Director to proceed with the roll call of participants before we embark on the various items on our agenda.

Thank you for your attention, and may I wish you a very successful meeting. ■

Full accounts of the Kyoto meetings will be published in the April 2004 issue of the OIML Bulletin

OIML TC 8/SC 1 MEETING

Static Volume Measurement

30–31 October 2003

Vienna, Austria

RICHARD GOBLIRSCH
BEV, Austria

The BEV Metrology Service recently took over responsibility for the Secretariat of OIML TC 8/SC 1, and so a kick-off meeting was held in Vienna during the last two days of October with the objective of starting work on the revision of a number of OIML Recommendations.

12 participants from six P-member countries (Austria, France, Germany, the Netherlands, Slovakia, Sweden) and one O-member country (Slovenia) attended the meeting and the OIML Recommendations concerned were:

- R 71 (1985) Fixed storage tanks
- R 80 (1989) Road & rail tankers
- R 85 (1998) Automatic level gauges for measuring the level of liquids in fixed storage tanks
- R 95 (1990) Ship tanks
- Project p2: Installation for gauging road & rail tankers

The discussion focussed on project p2, for which Germany had provided a comprehensive working paper. A presentation on the same topic was also given by a German company.

After intense discussion a procedure was adopted to cope with the workload of revising three or four Recommendations simultaneously. It was proposed to set up two new Working Groups (WGs) which would bring the Recommendations up to date and render them suitable for application within the *OIML Certificate System*, and these new WGs should be able to produce a 1 CD within a year:

- OIML TC 8/SC 1 WG2 (10 participants so far) would deal with the revisions of R 85 and R 71, and
- OIML TC 8/SC 1 WG3 (9 participants so far) would take on the revision of R 80, together with the adaptation of p2.

The revision of R 95, originally planned by WG1, was postponed.

A further meeting to discuss the output of WG2 and WG3 was scheduled to be held in December 2003, also in Vienna.

OIML TC 8/SC 3 & SC 4 JOINT MEETING

Dynamic Volume Measurement

Dynamic Mass Measurement

6–9 October 2003

Paris, France

Ralph Richter
NIST, USA

Introduction

A joint meeting of OIML TC 8/SC 3 *Dynamic volume measurement for liquids other than water* (Germany) and TC 8/SC 4 *Dynamic mass measurement for liquids other than water* (USA) was held from 6–9 October 2003. Hosted by the BIML at the Maison de la Chimie in Paris, the meeting was extremely productive and was very well attended by 45 participants, including official representatives from 17 Member States (17 P-Members of TC 8/SC 3 and 15 P-Members plus 2 O-Members of TC 8/SC 4). With participants from Japan, China, Australia, South Africa and Brazil, every continent was represented!

The main purpose of the meeting was to hold detailed discussions on several critical issues involved in the revision of OIML Recommendation R 117 *Measuring systems for liquids other than water*. This Recommendation is currently undergoing an extensive revision: new instrument technologies are being incorporated and it is being merged with OIML R 86 *Drum meters for alcohol and their supplementary devices* and R 105 *Mass flow measuring systems for quantities of liquids*.

This new version of R 117 will include measuring systems equipped with volumetric meters, turbine meters, electromagnetic meters, ultrasonic meters, vortex meters, drum meters, and mass flow meters.

R 117 Project history

During a joint meeting of OIML TC 8/SC 3 and TC 8/SC 4 held in February 2000, it was decided to establish two new working groups to revise and merge OIML R 105 and R 117. At that meeting, it was agreed that a new R 117-1 *Measuring systems for liquids other than water, Part 1: Metrological and technical requirements* would be developed to replace R 105 (1993) and R 117 (1995). When that work was completed, a new R 117-2 *Testing procedures and test report format for type evaluation of fuel dispensers for motor vehicles* would be developed by TC 8/SC 3 WG1 to replace R 118 (1995).

Based on a questionnaire sent out in December 2000 concerning drum meters for alcohol (currently covered by OIML R 86), it was decided to not revise R 86. Instead, measuring systems equipped with drum meters for alcohol will be included in the revised R 117-1, and R 86 will be withdrawn.

In June 2001, all 25 P-Members of TC 8/SC 3 were invited to participate in TC 8/SC 3 WG2 "Revision of R 117". Nineteen P-Members agreed to participate in this working group and these same P-members also agreed to participate in TC 8/SC 4 WG1 "Combination R 117/R 105".

In May 2002, a first proposal for the revision of Annex A of the revised R 117 entitled *Performance tests for electronic measuring systems* was sent for comment to the members of TC 8/SC 3 WG2.

The chairmen of the two Subcommittees and the convenors of the two working groups made significant progress on the R 117 revision during an informal meeting from 17 to 20 September 2002 at the PTB in Braunschweig, Germany. Discussions at this meeting were based on an early draft of the revised/combined R 117. The convenors of the two working groups, Mr. Ralph Richter (NIST, USA) and Mr. Aart Kooiman (NMi, The Netherlands), agreed to work closely together to complete the project on an aggressive (2002–2004) time schedule.

According to the time schedule, the first and second working drafts were developed and discussed by the working group convenors with the active participation of the national working groups of the United States and The Netherlands over the period November 2002 to February 2003. A third working draft (WD3) was drawn up, and in March 2003 the document was distributed to the international working groups (IWGs) for review and comment.

Over 540 comments on WD3 were received from members of the IWGs. Many of these comments were lengthy, technical, and thoughtful, often suggesting significant changes to entire sections of R 117-1. The convenors worked closely together in an attempt to respond to every comment and make all appropriate changes and improvements to the next draft of the document. Based on these comments, the convenors prepared a first Committee Draft (1CD) and sent it to the members of the IWGs in August 2003. The 1CD was also sent to all Participating and Observing members of OIML TC 8/SC 3 and TC 8/SC 4.

The meeting

Working from the 1CD of R 117 (August 2003), participants at the 6–9 October 2003 Paris meeting successfully completed a lengthy and detailed agenda designed to resolve several key issues concerning the revision of the document. The meeting was chaired by Dr. Detlev Mencke (PTB, Germany) with assistance from Mr. Richter and Mr. Kooiman.

In addition to the 17 P-Member countries, several representatives of major manufacturers of these systems and liaison organizations actively participated in the meeting. These technical experts provided a depth of experience and technical expertise that proved highly valuable during the meeting.

Members of the IWGs were consulted before the meeting to help ensure that the most important issues in R 117 were given adequate discussion time early in the meeting. The following are just a few of the key issues discussed:

- Conversion devices. An entire section of the 1CD was rewritten to allow three different approaches to verify a conversion device;
- Electronic sealing. Convenors rewrote the entire section in the 1CD. After much discussion, the new section was accepted with minor editorial changes;
- Requirements for different types of gas elimination devices;
- Significant faults;
- Verification of checking facilities;
- Severity levels for performance testing; and
- Documentation required to accompany an application for a type approval certificate, and information required on the certificate.

Most of the discussions were lively and generally, consensus was reached among participants. Proposed changes to the R 117 text were made in real-time and were projected for participants to view and discuss. As required, some new terminology was added and other terminology edited. A few issues on which there was a lack of clear consensus were voted on by the quorum of Subcommittee P-Members.

Participants expressed satisfaction with the productivity and accomplishments of the meeting in working towards a new draft Recommendation R 117-1.

Next steps

A few participants at the Paris meeting accepted assignments to draft proposals for revised text in particular sections of the document. All other participants were encouraged to send any additional comments or edits on the 1CD to the WG convenors.

Based on consensus decisions at the Paris meeting and other comments received, the WG convenors plan to send out the 2CD of R 117-1 for vote and comment in January 2004. ■

Participants at the October 2003 Joint Meeting of OIML TC 8/SC 3 and TC 8/SC 4

INTERNATIONAL WORKSHOP

Future Aspects of Software and IT in Legal Metrology (FASIT)

25–26 September 2003

Ljubljana, Slovenia

TANASKO TASIĆ, MIRS

Introduction

An International Workshop on *Future Aspects of Software and IT in Legal Metrology* (FASIT) took place on September 25th and 26th in Ljubljana, Slovenia, jointly organized by the Metrology Institute of the Republic of Slovenia (MIRS) and MID-Software (www.mid-software.org), a project within the EU 5th Framework Program.

The aim of the MID-Software project is to support the implementation of the MID by preparing guidelines which will enable common interpretation of software requirements among manufacturers and legal metrology bodies in Europe and by establishing mutual confidence in the results of software testing. The project consortium consists of six national metrology institutes (PTB, NMi, SP, NWML, GUM, IPQ, MIRS), two notified bodies (DELTA, LNE) and seven manufacturers of legal metrology instruments (HALE, Herbert and Sons, GILBARCO (former Marconi), Mettler Toledo, Sartorius, Landis & Gyr (former Siemens Metering)).

Background information

The project work is split into work packages ("WP") which:

- Draw up requirements (WP 1.1, WP 1.2 and WP 1.3),
- Draw up validation guidance (WP 2),
- Analyze linkage between legal metrology requirements and existing international software and IT standards (WP 3),
- Analyze future aspects of software in legal metrology instruments (WP 4), and
- Coordinate the project (WP 5).

The idea behind the Workshop stemmed from a project meeting in Ljubljana in October 2002, during the presentation of WP 4 (*Future aspects*). The idea was to invite manufacturers of legal metrology instruments and others involved in software and IT in metrology to clear up and focus our vision of its future developments, since these developments already influence the work of legal metrology institutions, and will continue to influence it more and more in the future. WP 4 identified the following aspects as being necessary for immediate further investigation:

- Remote meter operation via various communication networks (internet, cable-TV network, power supply, mobile communication, etc.) - remote readout, identification and authentication of participants in data exchange, key infrastructure, software download, remote configuration and inspection, data security, integrity aspects, etc.
- Use of smartcards in legal metrology applications - readout, identification and authentication of participants in data exchange, key infrastructure, software download, configuration and inspection, data security, integrity aspects, etc.
- Multi-purpose measuring instruments and intelligent sensors.

Workshop realization

The event took the form of a two-day Workshop with 16 lectures, eight of which were given by representatives from industry. There were 57 participants from 13 European countries and Japan. The workshop had three main parts:

- Introduction related to technical legislation,
- Technical presentations by manufacturers, and
- Technical presentations based in experience gained in other fields that may be of use for legal metrology.

The contributions shown in the table on the next page were presented, and the presentations were followed by a panel discussion.

In addition to the presentations, a visit was organized to the MIRS Laboratory for Information Technology in Metrology, MIRS Mass Laboratory and the Laboratory for Metrology and Quality (LMK), Faculty of Electrical Engineering Ljubljana.

Presentations given at the Workshop

Dr. Ivan Skubic, Director of MIRS, Slovenia	Introduction to the FASIT Workshop
Mr. Jean-François Magaña, Director of BIML	OIML role and activities
Mr. Gerald Freistetter, Chairman of WELMEC, BEV, Austria	WELMEC role and activities
Dr. Roman Schwartz, Chairman of the WELMEC WG 7 "Software", PTB, Germany	The EU Directive on Measuring Instruments (MID); Development and implementation
Prof. Dr. Dieter Richter, Project co-ordinator, Head of Department 8.3: Metrological Information Technology, PTB, Germany	MID-Software: Overview of the project
Ms. Barbara Leitner, Hale Electronic, Austria	Advanced taximeter & organization solutions - integrating vehicle manufacturers, calibration offices and workshops
Mr. Samo Zorko, IskraEMECO, Slovenia	DLC and RF based AMR System with ME/MT 351 System Meters
Mr. Sandro Minuti, Gilbarco Veeder-Root, Italy	Fuel service station today and tomorrow - A perspective from legal metrology's point of view
Mr. Anton Rems, Ultra, Slovenia	Application of modern IT and software approaches to measuring process in oil industry
Dr. Satoshi Matsuoka, National Institute of Advanced Industrial Science and Technology (AIST), Laboratory for Verification and Semantics, Japan	Integrity check of embedded software via internet
Prof. Dr. Janko Drnovšek, Chairman of Slovenian National Metrology Board, Laboratory for Metrology and Quality (LMK), Faculty of Electrical Engineering, Ljubljana	Presentation of the Metrology System of the Republic of Slovenia
Mrs. Nataša Mejak Vukovič, Head of MIRS Legal Metrology Department	Presentation of legal metrology activities in Slovenia
Dr. Norbert Zisky, Head of Section 8.32: Measurement Data Transfer Technology, PTB, Germany	Presentation of SELMA project [Sicherer Elektronischer Messdaten Austauch]
Mr. David Pewter, Herbert & Sons, UK	MID weigh to the future!
Mr. Tadej Vodopivec, HERMES SoftLab, Slovenia	Useful experience from E-Banking and IT solutions for legal metrology
Mr. Roman Flegar, MIRS, Slovenia	Supporting infrastructure of the system for implementation of the MID
Dr. Jovan Bojkovski & Mr. Valentin Batagelj, Laboratory for Metrology and Quality (LMK), Faculty of Electrical Engineering, Ljubljana	Practical issues in transmission of measurement data via Internet
Mr. Iztok Saje, Mobitel, Slovenia	Transmission of telemetric data via public mobile network

Conclusions

As Mr. Sandro Minuti from Gilbarco said, the development of legal measuring instruments began with the "iron age", continued with the "electronic age" followed by the "software age" and now we are already in the "communication age".

From the presentations given during the FASIT Workshop we learned that the development of legal measuring instruments is moving in the direction of (or already is) distributed or "networked" measuring systems, which will:

- Add additional functionality and flexibility in the operation of measuring instruments (remote tariff or unit price change for taximeter, fuel dispenser, utility meter or scales, readout of utility meters, calibration, software update via download and other maintenance, etc.);
- Lead to measuring instruments actually being physically distributed over several locations;
- Lead to the use of centralized databases in measuring systems for measurement data collection for issuing invoices and various other functions (tariff calculation, maintenance, etc.);
- Have additional functions related to measuring instrument or system components that will require careful software separation (inventory management, etc.);
- Require high-level skills to prevent fraud; and
- Require much higher level skills for fraud detection and surveillance.

The event would have been even more successful if there had been more presentations from manufacturers of legal measuring instruments, or contributions from the meter provider community. Nevertheless, FASIT gave a good overview and orientation of probable future developments. The FASIT idea was similar to that of the 1999 OIML Seminar on software, and it is probably useful to consider the periodical organization of similar events to keep those involved informed about developing trends in this area. ■

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The OIML is pleased to welcome the following new

CIML Members

New Zealand

Mr. John Barker

Indonesia

Drs. Amir Saharuddin Sjahrial

OIML Meetings

2–5 February 2004 - Rio de Janeiro, Brazil

(Date and venue to be confirmed)

TC 12 Instruments for measuring electrical quantities (WG Meeting: Revision OIML R 46)

25–29 October 2004 - Berlin, Germany

Development Council Meeting

39th CIML Meeting

12th International Conference on Legal Metrology

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Committee Drafts

Received by the BIML, 2003.08.01 – 2003.10.31

Revision R 35: Material measures of length for general use	E	2 CD	TC 7	UK
Revision R 117: Measuring systems for liquids other than water	E	1 CD	TC 8/SC 3	DE
Test Report Format for R 125	E	2 CD	TC 8/SC 2	RU
Revision R 39: Rockwell hardness machines	E	2 CD	TC 10/SC 5	US
Revision D 1: Elements for a Law on Metrology	E	3 CD	TC 3	US
Newtonian viscosity standard specimens for calibration and verification of viscometers	E	1 CD	TC 17/SC 5	RU

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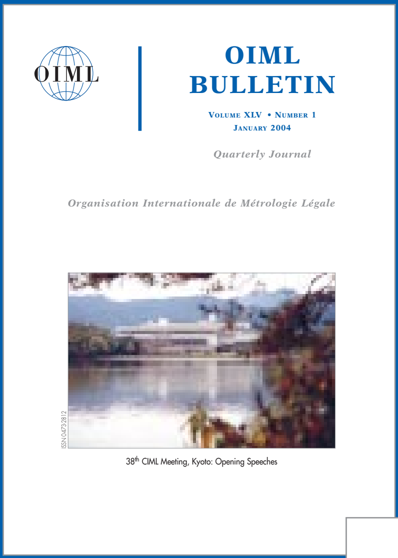

- Technical articles on legal metrology related subjects
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- the paper originals of any relevant photos, illustrations, diagrams, etc.;
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