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COOMET: 15 years of collaboration

History of Euro-Asian cooperation between national metrological institutions

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Editorial

RÉGINE GAUCHER
MAA PROJECT LEADER, BIML

OIML Mutual Acceptance Arrangement (MAA) News

The OIML MAA, which is a system for the recognition of test reports, increases confidence in type examination testing in order to facilitate the use of OIML Type Evaluation Reports among participating countries; it thus contributes to avoiding duplication of tests and examinations for manufacturers of measuring instruments.

Its implementation began in January 2005 and the signature of the first two Declarations of Mutual Confidence (DoMCs) is expected by the end of September 2006 for two categories of instruments: Load cells (R 60) and Nonautomatic weighing instruments (R 76).

The MAA is based on an evaluation of the Testing Laboratories of OIML Issuing Authorities according to ISO/IEC 17025 *General requirements for the competence of testing and calibration laboratories*. Demonstrating conformity to ISO/IEC 17025 may be done either:

- by an accreditation delivered by an accreditation body which is a full member of ILAC (International Laboratory Accreditation Cooperation) and which is an MRA signatory; or
- by peer assessments managed by the OIML.

In both cases, the evaluation is conducted in close cooperation between ILAC and the OIML.

As an additional tool to the OIML Certificate System, the OIML MAA offers a "one-stop testing" concept and facilitates type approval of measuring instruments in various countries. The Type Evaluation Report attached to the OIML Certificate of Conformity issued under the MAA will be recognized by all the signatories of a DoMC.

In order to identify those OIML Certificates of Conformity and Type Evaluation Reports issued under a DoMC, a specific OIML/MAA logo has been created (see below).

In addition, DoMCs are not only based on the requirements of the relevant OIML Recommendations but also take into account accepted additional requirements from signatories. This means that the Type Evaluation Report containing these additional test results may be utilized in countries where national regulations are not fully aligned with the OIML requirements. Manufacturers who are aware of the additional requirements covered by a DoMC will be able to include them in their testing program at the beginning of the process in line with those countries in which they will request type approval.

To conclude, the OIML MAA offers manufacturers:

- a "one-stop testing" process for type approval worldwide;
- better information at the beginning of the process when deciding on tests to be performed;
- recognized confidence in test results;
- the use of Type Evaluation Reports for type approval also in countries where national regulations are not fully aligned with OIML Recommendations; and
- an accelerated type approval process.

The OIML MAA is certainly an additional tool which will make access to the global market easier for manufacturers, in particular because its scope is wider than that of existing bilateral and regional mutual acceptance/recognition agreements. ■

OIML MUTUAL ACCEPTANCE ARRANGEMENT

www.oiml.org/maa

WEIGHING

Averaging results of single substitution weighing

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Abstract

In substitution weighing the weighing process is carried out in substitution cycles. From every substitution cycle a value for the mass difference between two objects is obtained. To secure the reported result the cycles are repeatedly processed. The final mass difference results from averaging the individual cycle differences. A sequence of substitution cycles also defines the experimental standard deviation, which is used for the determination of the type A standard uncertainty [1], [2].

Generally, substitution procedures are necessary to eliminate the impact of drift. A different kind of weighing pattern is used in substitution weighing, and the single and double substitution procedures are very common. From the statistical point of view, however, it is also important to focus on the individual readings within the substitution cycles. It must be anticipated that the deviations of the readings from their ideal values are treated as equivalent incidental events, which are independent from each other. In a double substitution procedure the cycle differences would also comply with such a statistical condition, which is why averaging the cycle differences in this case through the arithmetic mean would be correct. This study shows that for single substitution, however, arithmetic means are not applicable.

This paper focuses on correlated substitution cycles, as the problem of averaging depends on the correlations between the cycle differences. A typical example for correlating cycles is the common single substitution, because due to the S T S pattern adjacent cycles contain the same reading for the standard. Correlations between substitution cycles have already been examined before; however, the approach of this contribution may complete the results of past studies [3], [4], [5], [6], [7], [8].

Introduction

In substitution weighing every cycle difference is determined by the individual readings (observations). For conventional mass values the weighing equation per cycle i is

$$m_\mathrm{B}\left(1-\frac{\rho_{\mathrm{a}i}-\rho_0}{\rho_\mathrm{B}}\right)-m_\mathrm{A}\left(1-\frac{\rho_{\mathrm{a}i}-\rho_0}{\rho_\mathrm{A}}\right)=\Delta Y_i$$

The left side of the weighing equation describes the change of the load on the receptor of the mass comparator. The material densities ρ_A and ρ_B are known parameters. Per cycle the densities $\rho_{\mathrm{a}i}$ of the air are considered as constant, because for every cycle average values are used. On the right side of the equation i = 1, 2, …, n are the cycle differences ΔY_i to be measured [1]. To facilitate the mathematical approach for this data set, vector denotation will be used in this paper. For the load differences on the left side of the weighing equations one obtains

$$\Delta L = m_\mathrm{B}\left(1-\frac{\rho_\mathrm{a}-\rho_0}{\rho_\mathrm{B}}\right)-m_\mathrm{A}\left(1-\frac{\rho_\mathrm{a}-\rho_0}{\rho_\mathrm{A}}\right)$$

The load difference vector ΔL varies with variations of the vector ρ_a of air densities. On the right side of the weighing equation are the observations defined by the vector ΔY of the cycle differences. In vector denotation, the set of weighing equations is simply expressed by

$$\Delta L = \Delta Y$$

Regardless of which substitution pattern is in use, between the cycle differences and the individual readings there is a linear relationship. This relationship is the substitution pattern and is defined by the pattern matrix X_p. It combines the cycle differences with the readings by

$$\Delta Y = X_\mathrm{p} Y$$

Example

In the special case of two single substitution cycles the pattern matrix is

$$X_\mathrm{p}=\begin{bmatrix} -\frac{1}{2} & 1 & -\frac{1}{2} & 0 & 0 \\ 0 & 0 & -\frac{1}{2} & 1 & -\frac{1}{2} \end{bmatrix}$$

As there are 5 readings the vector Y comprises 5 elements. The vector ΔY of the cycle differences comprises 2 elements. Carrying out the matrix multiplication yields the commonly known single substitution cycle differences

$$\Delta Y_1 = Y_2 - \frac{1}{2}(Y_1 + Y_3)$$

$$\Delta Y_2 = Y_4 - \frac{1}{2}(Y_3 + Y_5)$$

In the case of more than 2 cycles the dimension of the pattern matrix must be increased accordingly using the elements – 1/2, 1 and 0.

To include the possibility of different patterns during a substitution sequence the individual rows of the pattern matrix can be structured differently. Thus for example a double substitution cycle can be combined with a single substitution cycle. In any case using the pattern matrix establishes the relationship between the load differences and the individual readings by

$$\Delta L = X_p Y$$

On the left side of this equation is the unknown conventional mass value m_B to be determined. The air densities that can be determined through measurement of their parameters [1]. Constant parameters are the material densities ρ_A and ρ_B. Further there is the conventional mass value m_A of the reference. Of course, this equation expresses just the same calibration formula commonly in use. However, for the next consideration this mathematical form for the weighing equations will be rather useful. At the end a solution for m_B is expected from this set of equations.

To find a solution, principally from a set of readings the average is calculated. The resulting value is a linear function of the readings. Thus using vector denotation the average cycle difference can be expressed in form of

$$\overline{\Delta Y} = w^T \Delta Y$$

The coefficients of the differences are the components of the vector w. This is the weighting vector for averaging. The attachment of the T symbolizes that here the components of the weighting vector are arranged horizontally. Through transposition a vertical arrangement can be changed to a horizontal arrangement and vice versa.

In the case of an arithmetic mean the components of the weighting vector are known to be 1/n, because the same weighting factor would be applied to every cycle difference [1]. It will be examined, however, whether the arithmetic mean is generally applicable to cycle differences. This study will provide the weighting factors dependent on the substitution pattern and the number of cycles.

Variances and co-variances

To determine the type A uncertainty resulting from the incidental variations of the readings, the variances of the average cycle differences will be examined. This requires some care, because depending on the substitution process the cycle differences can be correlated. For that reason not only the variances but also the co-variances of the cycle differences must be taken into account [5], [6]. At the end a relationship is expected between the variance of the average cycle difference and of the observation. As the average cycle difference results from the application of the weighting vector to the vector of cycle differences, its variance is

$$\sigma^2\left(\overline{\Delta Y}\right) = w^T E\left(\Delta Y \Delta Y^T\right) w$$

The symbol E denotes that expectation values are considered here. The introduction of the expectation values applies to all elements of the covariance matrix $\Delta Y \Delta Y^T$. For this reason the expectation values are also characterized by a covariance matrix. In the case of correlations between cycle differences, this covariance matrix would contain non-zero elements. It is exactly the pattern matrix X_p that defines whether there are co-variances of the cycle differences or not.

In any case at first it must be clear that the readings obtained are statistically independent from each other. Then their incidental deviations from their expectation values are defined by a single variance σ^2. All co-variances are 0. Therefore the expectation values of the elements of the covariance matrix YY^T are

$$E(Y\,Y^T) = \sigma^2 I$$

Here the matrix I is the identity matrix. This statistical condition and the application of the pattern matrix yield an expression for the variance of the average cycle difference:

$$\sigma^2\left(\overline{\Delta Y}\right) = \sigma^2 w^T X_p X_p^T w$$

This expression is the base to calculate the variance of the cycle difference. It can be used to determine the relationship between uncertainties obtained from different substitution patterns [5], [6], [8]. However, in the past the same weighting factors were applied. Now the correct weighting factors will be elaborated [8].

The principle of least variance

In general, best estimates for a variable to be measured are in compliance with the principle of least variance.

For example in the case of uncorrelated observations the result of the mathematical application of this principle would be the arithmetic mean of the obtained readings. Also the application of the least square method is nothing else than the realization of the principle of least variance. For this reason the parameters that contribute to the cycle difference average must be chosen in compliance with the minimum variance.

As already elaborated the variance of the average cycle difference depends on the weighting vector. The mathematical relationship is parabolic. The actual mathematical task is finding a solution for the weighting vector w dependent on the pattern matrix X_p so that the variance of the average cycle difference is at minimum. A zero vector as a trivial solution, however, is not applicable. To exclude the trivial solution a further condition is required. This is elaborated below.

The initial definition of the weighted cycle average must also comply with the ideal case that all readings do not vary from their expectation value and that the resulting average is not different from its expectation value:

$$E\left(\overline{\Delta Y}\right) = E(\Delta Y)$$

Then the definition of the weighted average is to be completed by the condition of normalization, which is

$$w^{\mathrm{T}} d = 1.$$

Here the vector d comprises elements 1 only (diagonal vector). Thus a linear equation for the weighting vector has been established. This equation ensures that the solution from the least variance is normalized. The mathematical task to find the minimum of the variance under the condition of normalization can now be solved.

The method of Lagrange multipliers will be used to find the solution. The variance of the average cycle difference is completed by a restraint in the form of

$$F(w,\lambda) = \sigma^2 w^{\mathrm{T}} X_{\mathrm{p}} X_{\mathrm{p}}^{\mathrm{T}} w + \lambda\left(w^{\mathrm{T}} d - 1\right) + \lambda\left(d^{\mathrm{T}} w - 1\right)$$

The function F varies with variations of the weighting vector w and the multiplier λ. In case the variance of the average cycle difference is at minimum and the weighting vector complies with the restraint, the gradient of the function F must be 0:

$$\frac{\partial F(w,\lambda)}{\partial(w,\lambda)} = 0$$

This is the necessary condition for a minimum of the variance, also including the restraint. It establishes the equation for the weighting vector. The solution ensures a minimum variance of the average cycle difference [8].

Designing the solution vector

The solution vector cannot be expressed through a single formula, because it comprises more than one element and depends on all elements of the pattern matrix. However, to design the solution vector using spreadsheet calculation is easy. Proceed as follows [8]:

1 Design the pattern matrix X_p according to the intended substitution weighing procedure. Check the number n of cycles.

2 Transpose the pattern matrix and calculate $X_p X_p^{\mathrm{T}}$. Check if the dimension of this matrix is n.

3 Expand $X_p X_p^{\mathrm{T}}$ by one row and one column.

4 For the additional diagonal element enter 0.

5 For the other additional elements enter 1. Now you have obtained the normal matrix

$$\left(X_{\mathrm{p}} X_{\mathrm{p}}^{\mathrm{T}}\right)_{\mathrm{e}} = \begin{bmatrix} X_{\mathrm{p}} X_{\mathrm{p}}^{\mathrm{T}} & d \\ d^{\mathrm{T}} & 0 \end{bmatrix}$$

6 Invert the normal matrix (Should this not be possible your pattern contains a logic error).

7 Extract the elements of the last column from the normal matrix inverse, but omit the last element.

$$\left(X_{\mathrm{p}} X_{\mathrm{p}}^{\mathrm{T}}\right)_{\mathrm{e}}^{-1} = \left[\begin{array}{ccc|c} \cdot & \cdot & \cdot & \mathrm{x} \\ \cdot & \cdot & \cdot & \vdots \\ \cdot & \cdot & \cdot & \mathrm{x} \\ \hline \cdot & \cdot & \cdot & \cdot \end{array}\right]$$

8 Realize that the extracted elements compose the weighting vector:

$$\begin{bmatrix} \mathrm{x} \\ \vdots \\ \mathrm{x} \end{bmatrix} \rightarrow w$$

9 You may check the normalization. The sum of the elements must be 1.

Examples

a) Double substitution

All weighting elements are $1/n$ as expected.

b) Single substitution

The following table shows the results that you obtain for the weighting factors

w		j				
		1	2	3	4	5
n	2	1/2	1/2			
	3	5/14	4/14	5/14		
	4	6/22	5/22	5/22	6/22	
	5	29/131	24/131	25/131	24/131	29/131

Weighting factor w for the cycle differences $j = 1, \ldots, 5$ in substitution sequences with $n_c = 2, \ldots, 5$ cycles

For 2 cycles the arithmetic mean applies. Only in that case there is no difference to the common practice. Of course, due to symmetry another solution would not be possible. However, for 3 cycles and more the arithmetic mean is not applicable.

The examples show the impact of correlations on the average cycle difference. It is good to realize that using individual weighting factors for the cycle differences would not much affect the work load in calibration. In the case of single substitution it is recommended to just use the factors listed in the table.

As far as the type A uncertainty is concerned it would be convenient also to base the calculation on cycle differences [7]. Then the uncertainty would be derived directly from the weighted cycle differences. Principally this method is an approximation, but it is sufficient [8]. For this reason the uncertainty budget of the conventional mass of the test object would not be affected much through the use of weighting factors.

The remaining question finally concerns the buoyancy correction.

Solution for the conventional mass

The correct buoyancy correction results from the weighing equation. Now the air densities obtained per cycle can be averaged by applying the weighting factors: When the weighing equation is multiplied with the weighting vector one obtains

$$w^{\mathrm{T}} \Delta L = \overline{\Delta Y}$$

The average air density now is

$$\overline{\rho_{\mathrm{a}}} = w^{\mathrm{T}} \rho_{\mathrm{a}}$$

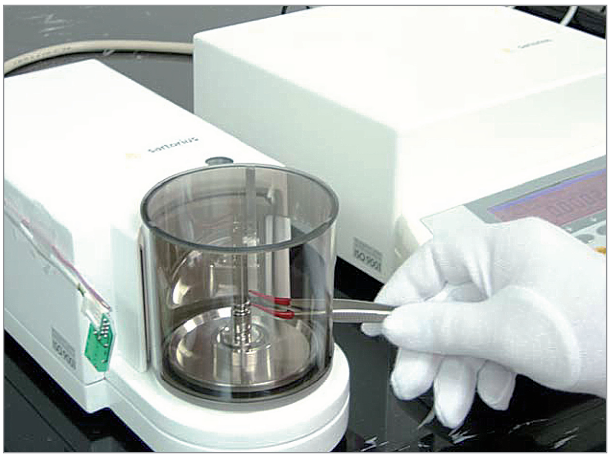
So also with regard to the air density, the correct weighting factors must be applied. Thus the form of the common weighing equation for conventional mass does not really change:

$$m_{\mathrm{B}}\left(1 - \frac{\overline{\rho_{\mathrm{a}}} - \rho_0}{\rho_{\mathrm{B}}}\right) - m_{\mathrm{A}}\left(1 - \frac{\overline{\rho_{\mathrm{a}}} - \rho_0}{\rho_{\mathrm{A}}}\right) = \overline{\Delta Y}\,.$$

Application

The calibration laboratory INSCO Metrology, Miami, USA bases its calibration procedures on OIML R 111. During the past years the double substitution pattern was used.

After the achievement of a solution regarding the problem of correlated cycle differences INSCO has started using the single substitution pattern as well. As large quantities of objects are to be calibrated, the issue of best handling is of importance. It appears that single substitution is better accepted by those involved in practical calibration work. As a result software has been compiled based on correctly averaging cycle differences. After examining the application of single substitution in a first experimental phase INSCO will now expand its calibration procedures accordingly.



Single substitution on a 10 g – mass comparator of d = 0.1 μg

Up to now the new procedure is used for manually operated calibrations only. In detail the operations are:

1 The mass comparator is loaded subsequently by the standard S and the calibration object T according to the substitution pattern S T S T S ...
2 From every weighing after stability of the instrument a reading is obtained. The weighing value is transferred to the computer using the print function of the comparator.
3 Simultaneously the actual values for pressure, temperature and relative humidity are recorded.
4 For every cycle S T S the cycle difference of the readings is calculated.
5 For every cycle also the average values of the air density parameters are calculated.
6 Per cycle the average air density is calculated from the average values of the air density parameters.
7 The minimum number of cycles to be carried out per calibration depends on the class of the calibration object. For class E_2 the minimum number of cycles is 3.
8 Using the correct weighting factors the weighted cycle differences are calculated.
9 The same weighting factors are used to calculate the average air density during the complete set of cycles.
10 Finally the conventional mass of the calibrand is calculated.

Of course, the procedure for double substitution is not much different. However, the application to single substitution compared to double substitution is advantageous for the following reasons:

a) Every new cycle in a weighing sequence requires just 2 more readings instead of 4. This makes the decision for the number of cycles to be carried out easier. In the end fewer weighings will be needed per calibration.

b) Generally the elimination of drift is based on the assumption of a linear progress of weighing data per cycle. As the single substitution procedure is based on 3 readings per cycle instead of 4 it better fits to changes of the drift [8].

c) The incidental deviations of the weighing values of the cycles from linearity define the type A uncertainty. For this reason in general from single substitution a smaller uncertainty can be expected.

The advantages of the single substitution pattern generally are well known. On the other hand because of the problem of correlated cycles this pattern was not well accepted. Now, after solving the problem of correlation, the advantages of single substitution dominate, so that calibration laboratories may reconsider their procedures.

Summary

In the case of correlated substitution cycles, particular weighting factors are to be applied when averaging the cycle differences.

The calculation of the weighting factors is based on the pattern matrix that represents the substitution process.

In the case of double substitution there is no change to common practice. Single substitution, however, requires non equal weighting factors dependent on the total number of cycles and their position in the substitution sequence. The values are reported in this paper.

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OIML R 125

Measuring systems for the determination of the mass of liquids in storage tanks

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Abstract

OIML R 125 specifies the metrological and technical requirements for the pattern approval and verification of instruments used to determine the mass of liquid contained in a tank using methods which measure the mass-related properties of the liquid while it is in a static state. But it does not include instruments which determine the mass of the liquid by methods such as weighing, or measuring the volume and the density and converting this into mass. This paper presents a method based on the hydrostatic pressure of the liquid determining the mass of the liquid directly in accordance with OIML R 125.

1 Scope

The quantity of a static liquid can be given either by volume V or by mass m, whereas the specification by mass is to be preferred to that by volume, since the mass is not dependent on temperature and density (contrary to the volume). The conversion from volume into mass or from mass into volume can be carried out according to the relation:

$$m = \rho \times V$$

if the density ρ of the liquid is known.

A determination of the mass by measuring the volume and the density is not easy to carry out, since the density values obtained are not really representative because of fluctuations of density in the medium. In order to minimize these effects it is advisable to take a lot of samples for the determination of density. Anyway, the uncertainties of the determination of mass obtained by a measurement of volume and density are usually greater than 0.5 % of the calculated value. Otherwise, the more exact gravimetric determination of the mass of a liquid in a storage tank by weighing the storage tank ($U \leq 0.1$ %) is only possible for relatively small storage tanks.

The procedure for a direct mass determination of liquids in vertical cylindrical storage tanks as described in the following is easy to carry out and makes a sufficiently exact mass determination possible ($0.3\ \% \leq U \leq 0.5\ \%$). By means of a differential piston gauge the hydrostatic pressure on a (lower) reference level is determined, by which a calculation of mass can be carried out taking into account the known cross-sectional area of the storage tank [1].

2 Theoretical model

The liquid column above the dip-plate level gives rise to a hydrostatic pressure, which also depends on the height of the column and on the density of the liquid in the storage tank. If h is the height of the liquid column and ρ the density of the liquid, then:

$$\Delta p = \rho \cdot g \cdot h \qquad (1)$$

where Δp is the difference of pressure between the surface of the liquid and the (lower) reference level and g is the acceleration due to gravity. For the mass m the following applies:

$$m = \rho \cdot V = \rho \cdot h \cdot A \qquad (2)$$

where A is the mean cross-sectional area of the storage tank between the surface of the liquid and the reference level. Substituting for h according to (1) in (2) leads to

$$m = \rho \cdot \frac{\Delta p}{\rho \cdot g} \cdot A = \frac{\Delta p}{g} \cdot A \qquad (3)$$

This shows that the mass is completely determined by the parameters Δp, A and g. In order to determine the mass, it is therefore sufficient if one knows the difference of the pressure at the surface of the liquid and that in the lower reference level, the mean cross-sectional area of the storage tank and the acceleration due to gravity at the site of the storage tank.

Equation (3) is only a first approximation, of course, which has to be corrected. It is assumed implicitly that the density of air above the surface of the liquid is the same everywhere. This is not the case, since the air density and pressure increase as height decreases. The change in pressure can be assumed as linear within the measuring range of the tank; so for the change of the air pressure Δp_A applies:

$$\Delta p_A = f_A \cdot (h_{max} - h) \tag{4}$$

where h_{max} is the distance between the upper reference level and the lower reference level. Therefore we have to complete equation (1) as follows:

$$\Delta p - \Delta p_A = \Delta p - f_A \cdot (h_{max} - h) = \rho \cdot g \cdot h \tag{5}$$

where Δp is now the pressure difference between the upper and the lower reference level. This leads to:

$$m = \frac{\Delta p - f_A \cdot h_{max}}{g} \left(\frac{\rho \cdot g}{\rho \cdot g - f_A} \right) \cdot A \tag{6}$$

But also the mean cross-sectional area of the storage tank changes due to the head of liquid in the tank. If ΔA represents this change of the cross-sectional area, then for the mass m of the liquid equation (7) applies:

$$m = \frac{\Delta p - f_A \cdot h_{max}}{g} \left(\frac{\rho \cdot g}{\rho \cdot g - f_A} \right) \cdot (A + \Delta A) \tag{7}$$

For the change of the mean cross-sectional area of the storage tank equation (8) applies [2]:

$$\Delta A \cong \frac{2\pi \cdot (\rho - \rho_{ref}) \cdot g}{E} \sum_{i=1}^{n} \frac{r_i^3}{t_i} \cdot \left[\Delta h_i \cdot \left(1 - \frac{h_i + h_{i-1}}{2h_n} \right) \right] \tag{8}$$

where ρ_{ref} is the density, which is the base for the calculation of the capacity table, E is Young's modulus of elasticity, r_i are the mean radii of the single courses, t_i is the thickness of the courses, Δh_i is the height of the courses and h_i is the distance of the upper edge of the i^{th} course from the lower reference level, where $h_n = h$ applies.

For the mass m of the liquid equation (9) applies:

$$m = \frac{\Delta p - f_A \cdot h_{max}}{g} \left(\frac{\rho \cdot g}{\rho \cdot g - f_A} \right) \cdot \left\{ A + \frac{2\pi \cdot (\rho - \rho_{ref}) \cdot g}{E} \sum_{i=1}^{n} \frac{r_i^3}{t_i} \cdot \left[\Delta h_i \cdot \left(1 - \frac{h_i + h_{i-1}}{2h} \right) \right] \right\} \tag{9}$$

If all corrections shall be carried out as given above, a series of parameters has to be known besides the difference of pressure, the mean cross-sectional area of the storage tank and the acceleration due to gravity. These include, especially, the factor f_A for the correction of the air pressure for the altitude and the density ρ of the liquid. The remaining parameters are constant quantities, which can be taken either from the calibration certificate or from the tank calibration data.

The factor f_A has to be determined as follows [1]:

$$f_A = 1.25 \times 10^{-4}\ \text{m}^{-1} \times P_A \tag{10}$$

where P_A is the atmospheric pressure in the upper reference level in Pascal. For the standard pressure of 101 325 Pa the following applies:

$$f_A = 1.25 \times 10^{-4}\ \text{m}^{-1} \times 101\,325\ \text{Pa} = 12.67\ \text{Pa} \cdot \text{m}^{-1}$$

The density ρ of the liquid can be determined by a measurement only insofar as the value determined in a part of the liquid is not representative of the whole liquid in the tank. It can be determined hydrostatically as follows: the hydrostatic pressure acting at a height Δh above the lower reference level but at a level within the liquid will be subtracted from the hydrostatic pressure acting at the lower reference level. For the resulting pressure difference $\Delta p'$ the following applies:

$\Delta p' = \rho \cdot g \cdot \Delta h$ and therefore:

$$\rho = \frac{\Delta p'}{g \cdot \Delta h} \tag{11}$$

The relative uncertainty of the determination of the density ρ of the liquid adds to the relative uncertainty of the determination of the mass m as follows: for a density $\rho \geq 650$ kg/m^3 the contribution due to the correction of the air pressure is $\leq 2.0 \times 10^{-3}\ U_\rho/\rho$ and a deformation of the storage tank due to hydrostatic pressure is $\leq 1.5 \times 10^{-3}\ U_\rho/\rho$; Therefore, even in the case of a strict correlation of the two uncertainty components where they have to be added arithmetically this leads to a contribution to the relative uncertainty U_m/m of the mass being $\leq 3.5 \times 10^{-3}\ U_\rho/\rho$.

The mass m of an amount of liquid above the lower reference level can be determined by the procedure as described above. For inventory or for fiscal control the mass of the whole amount of liquid in the storage tank has to be determined. This is the sum of the mass m of the amount of liquid above the lower reference level and the mass m_o of the amount of liquid below, which can be determined as the product of the volume V_o below the lower reference level and the density ρ of the liquid. For the mass m_{total} of the total amount of liquid in the storage tank, equation (12) applies:

$$m_{total} = m + m_o = m + V_o \cdot \rho \quad (12)$$

where V_o can be found in the calibration certificate.

The relative uncertainty of the determination of the density ρ of the liquid adds to the relative uncertainty of the determination of the mass m_o of the amount of liquid below the reference level and is:

$$V_o \cdot U_\rho / m_o = U_\rho / \rho \quad (13)$$

Therefore the contribution of the relative uncertainty of the determination of the density to the total relative uncertainty $U_{m + m_0} / (m + m_0)$ of the mass of the total amount of liquid in the storage tank is:

$$\leq [3.5 \times 10^{-3} \; m/(m + m_o) + m_o/(m + m_o)] \cdot U_\rho/\rho \quad (14)$$

3 Technical realization

In order to be able to use the theoretical model as described above in practice, a measuring system for the determination of the mass of liquids in storage tanks (see Fig. 1) should consist of the following components:

- One or more storage tanks (1);
- Bubble gas supply including valve control (2);
- Piston system (pressure sensor) with hydraulic part as transducer (3-5);
- Weighing instrument as force transducer (6);
- Electronic system for data evaluation (7).

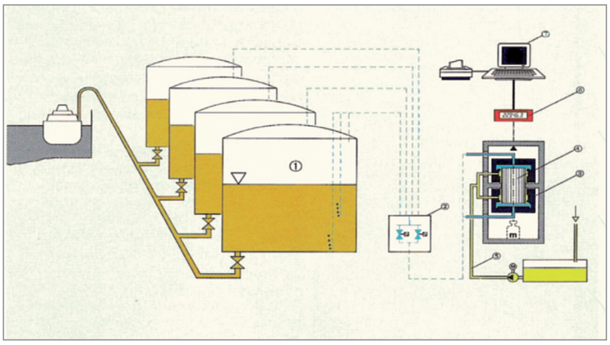

Figure 1 Measuring system for the determination of the mass of liquids in storage tanks

For the direct determination of the mass of liquid in a storage tank the pressure of the head of liquid in the lower reference level (dip-plate level) is transferred to a column of gas by a bubbling system (see Fig. 2), where a small amount of the gas (N_2 or CO_2) penetrates from a chamfered opening of the pipe. The pressure at this opening is transferred by a further pipe, which ends in the pipe above the upper edge of the storage tank (see Fig. 2), to a pressure sensor installed outside the storage tank. The transfer of pressure of the head of liquid on the pressure sensor is carried out without loss by the gas column standing in this pipe.

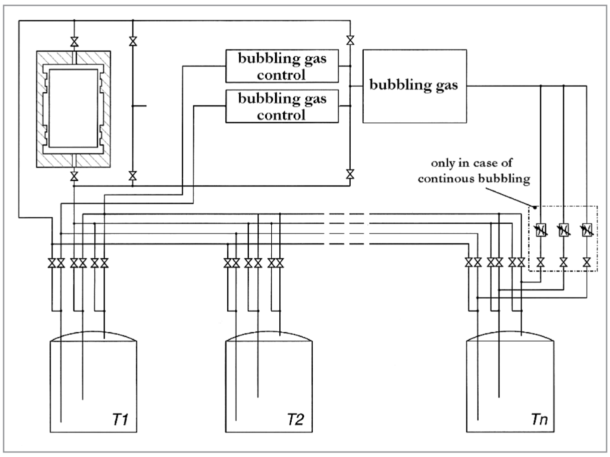

Figure 2 Bubbling system

In order to compensate the gas pressure above the liquid, the pressure in a specific reference level is transferred by a pipe without loss at the same time to a pressure sensor (see Fig. 4), acting as a transducer. This reference level has to be situated above the maximum filling height. The force resulting from the pressure difference and the piston cross-sectional area is transferred by a lever transmission to an automatic self-indicating weighing instrument of accuracy class II and indicated in units of mass (g or kg), taking into account the acceleration due to gravity. The indicated value is transferred to evaluation electronics where data processing, indication of the value and registration take place.

For the determination of the density of the liquid in the storage tank, a further pipe is installed in a given distance Δh. The pressure difference $\Delta p'$ between this level and that in the lower reference level is used for the calculation of the density according to equation (11).

By a check switch system (see Fig. 3) a particular storage tank out of several tanks can be chosen and connected to a weighing unit consisting of a pressure sensor, a lever transmission and a weighing instrument. So, valves are installed in the pressure lines as well as in the bubble gas lines of each storage tank which are switched and controlled by a central control unit. Systems with continuous bubbling comprise additional valves in the bubble gas lines (see Fig. 2). The pressure and bubble gas lines are always under measuring pressure up to these valves, by which on the one hand the pressure lines are kept clean and on the other hand the switching time is reduced essentially.

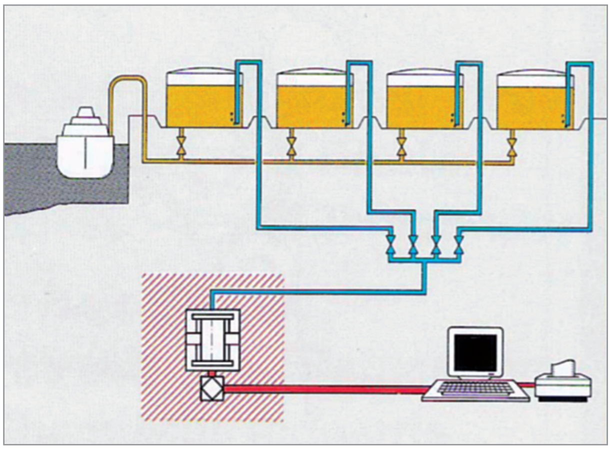

Figure 3 Check switch system

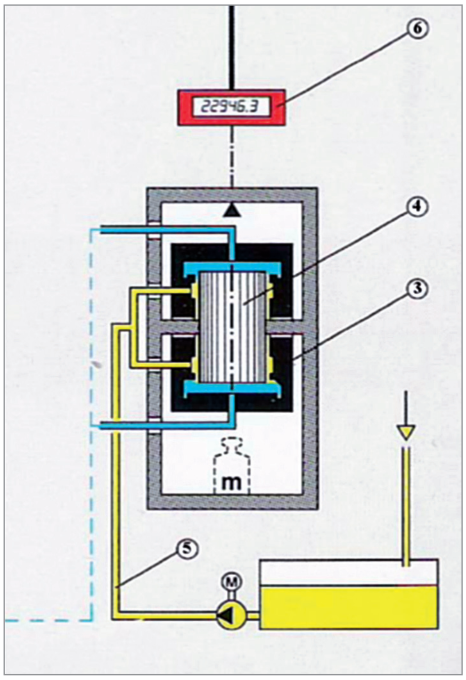

Figure 4 Pressure sensor

3.1 Pressure sensor

The central component of the measuring system for the determination of the mass of liquids in storage tanks is a pressure sensor (see Fig. 4), the central part of which is a measuring piston (4) guided without friction in a cylinder (3). A hydraulic unit (5) is responsible for the hydraulic pressure between piston and cylinder which is controlled by a pressure switch. By the hydraulic liquid, frictionless separation and sealing between piston and cylinder is achieved. The measuring piston acts by a lever transmission on an electronic weighing instrument (6), which is connected to evaluation electronics by a data line. By a gas displacement device the liquid head on the lower reference level of the storage tank is applied on the upper part of the measuring piston, the liquid head on the upper reference level on the lower part of the measuring piston. The mass m of the liquid head above the lower reference level is calculated in accordance with the pressure difference as determined above, the local acceleration due to gravity and the relation of cross-sectional area of the piston and mean cross-sectional area of the storage tank.

3.2 Determination of the measured value

The measured value is based on the mass m_{ind} indicated at the weighing instrument, which can be written as follows:

$$m_{ind} = \frac{\Delta p}{g} A_{piston} \tag{15}$$

where A_{piston} is the cross-sectional area of the piston in the pressure sensor. According to equation (3) the mass m of a liquid in a storage tank can be calculated in a first approximation as follows:

$$m = \frac{\Delta p}{g} \cdot A_{tank} = \frac{\Delta p}{g} \cdot A_{piston} \cdot \frac{A_{tank}}{A_{piston}} = m_{ind} \cdot \frac{A_{tank}}{A_{piston}} \tag{16}$$

If one takes into account the corrections for the change of air pressure which is dependent on height and the change of the mean cross-sectional area of the storage tank because of the liquid head, for the calculation of the mass m the following equation applies:

$$m = (m_{ind} - \Delta m) \cdot \frac{\rho \cdot g}{\rho \cdot g - f_A} \cdot \frac{A_{tank} + \Delta A}{A_{piston}} \tag{17}$$

where:

$$\Delta m = \frac{f_A \cdot h_{max}}{g} \cdot A_{piston} \tag{18}$$

applies.

3.3 Control devices

Under the condition of mandatory verification the measuring system for the determination of the mass of liquids in storage tanks has to comprise the following control devices.

The electronic weighing instrument of accuracy class II acts as a transducer and has to be provided with the following error detection functions:

- A check weight is installed in the weighing instrument, which can be put on automatically for calibration by a motor at the startup in order to check the analogous part;
- Errors in the digital part of the weighing instrument are indicated at the weighing instrument as well as at the indicating unit of the evaluation electronics for data processing and have to lead to a blockage of the whole system;
- With each switching or selection of a storage tank the pressure sensor has to experience atmospheric pressure on both measuring openings so the zero position of the weighing instrument can be checked. If the deviation is greater than a given margin of error, an error message will appear and the measured value display will be disabled.

The evaluation electronics for data processing has to be provided with an error detection function, which ensures that errors in this part of the system are identified and indicated at the indicating unit of the evaluation electronics. In case an error is identified, an error message has to be given and the processing of measured values has to be inhibited. The program for the processing of measured values has to be stored in such a way that no changes in the program flow or changes or manipulations of the processing and of the indication of measured values are possible.

The blockage of the indication or of the processing of measured values can be canceled only by an appropriate adjustment and a new calibration of the weighing instrument or by fixing the error, respectively. ■

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CONFORMITY ASSESSMENT

Uncertainty in conformity assessment in legal metrology (related to the MID)

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Abstract

Within trade, but increasingly also within the health and environmental sectors, the confidence needed to avoid unnecessary repeated measurements, disputes or legal actions can be provided by legal metrology. An important recent step is the introduction of the Measuring Instruments Directive (MID) [1]. The present Nordic project examines appropriate measurement requirements - focusing amongst others on the treatment of measurement uncertainty for verified measuring instruments in legal metrology. This paper provides a basis for discussions on how to establish principles and uniform procedures for handling measurement uncertainties in relation to maximum permissible errors for the different measuring instruments.

Introduction and general considerations

In today's society, measurements are used for many applications not only in industry and science but also in day-to-day life. Measurements are involved when purchasing petrol or food, when trying to keep to the speed limit when driving, when the doctor measures your blood pressure, or when the authorities make measurements to control air pollution. The common factor to all these measurements is that they need to be accepted (with confidence) to avoid repeated measurements, disputes and legal actions. In most cases, the consumer or even the user of the measuring instrument have neither the knowledge nor the possibility or equipment to check whether the measurement that is so important for us is correct or not. In all countries, the authorities have therefore decided to set accuracy requirements for key measurements. The most common of these are measurements related to trade, but increasingly, also those related to the health and environmental sectors.

Ongoing harmonization in Europe will help the authorities in the establishment of requirements for measurements as these are partly stated in various Directives, amongst others the MID. There remains, however, a need to further clarify how the metrological characteristics of various measuring instruments are specified and handled in legal metrology, for instance when assessing conformity in different modules of the MID. Examples of earlier work in this field include reviews of requirements of weighing in legal metrology [2] and of the role of measurement uncertainty in conformity assessment in legal metrology and trade [3]. This process of clarification will hopefully help avoid the undesirable establishment of different "levels of what is good enough" for the same application in different countries by harmonizing routines for implementation of the MID and other parts of legal metrology.

Against this background, this Nordic project is developing a Guide (specifically in relation to the handling of measurement uncertainty when assessing instrument conformity to the requirements of the MID) as a support to authorities and to further control the surveillance needed by the authorities to establish the necessary confidence in these measurements.

After an overview of conformity assessment and how specifically metrological instrument characteristics fall under the scope of the MID, the Guide then summarizes the requirements on measurement uncertainty in the Directive. A brief discussion of how to evaluate measurement uncertainty is followed by a main section concerning how measurement uncertainty and associated risks are dealt with in decision-making in the MID. Some more detailed discussions of a more technical nature are deferred to a number of annexes. The Guide concludes with a number of examples and recommendations for the future.

The MID and metrological characteristics

Conformity assessment

The MID prescribes a system of control in legal metrology aimed at providing confidence for the consumer and supplier alike that requirements on products and services are met, specifically in sectors where such confidence is essential, such as health, safety, environmental protection and fair trading.

The first step is to formulate a specification based on a balance between consumer demands and supplier promises. When making a decision about whether a product meets specifications, in general both qualitative attributes as well as quantitative variables associated with the product may be inspected and measured. Limited sampling and measurement uncertainties can lead to certain risks that incorrect decisions of conformity of product may arise, with some consequences for both consumer and supplier. Those products judged to be conforming are certified.

In legal metrology in Europe, mainly the notified bodies act as third parties in product conformity assessment.

Metrological requirements

The MID stipulates a system of control of various types of measuring instrument, including various routes to certification. Amongst others, it requires a definition in the technical documentation of the metrological characteristics of the instrument under assessment, that is, of those factors [4] (such as repeatability, stability, etc.) which contribute to measurement uncertainty.

Specification with respect to metrological characteristics is in terms of instrument performance in different parts of the MID (see Figure 1). There is a progression from general towards more specific metrological requirements in going from Annex 1 through to the harmonized standards and normative documents. In addition to qualitative inspection and sampling, some routes to certification require quantitative testing of the performance of measuring instruments in terms of various metrological characteristics.

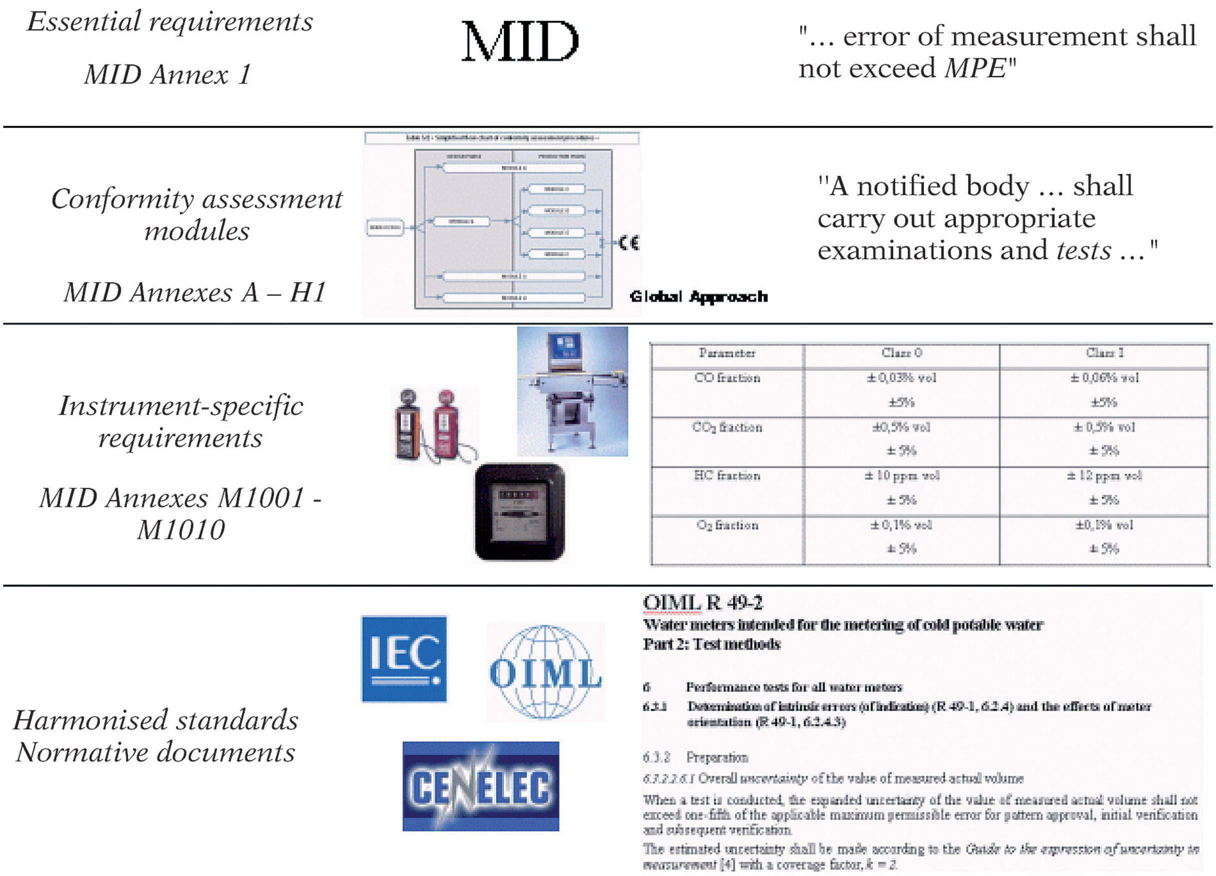

Figure 1 MID general and instrument-specific metrological requirements

The MID and requirements on uncertainties

Where quantitative testing of the metrological performance of an instrument is performed in accordance with the MID, uncertainties associated with measurement may need to be evaluated and accounted for when making decisions about conformity and assessment of risks and costs.

The result of a measurement, *y*, of the reading of a particular measuring instrument subject to MID conformity assessment must be accompanied by its measurement uncertainty, usually a so-called 'expanded' uncertainty *U* [5].

Requirements on measurement uncertainty are referred to in the MID through two separate channels:

- **quality assurance standards/norms** when referred to in the various modules of conformity assessment in annexes A – H1,
- **harmonized standards & normative documents** when referred to in the various instrument-specific annexes MI-001 to MI-010.

Measurement uncertainty requirements and conformity assessment modules

The MID follows the general structure of Directives in the framework of the EU Commission's New and Global Approaches [6].

For notified bodies, the EN 45000 series of standards is relevant according to the so-called 'blue guide' [7]. Specifically for the MID type examination Module B, the relevant standards referred to – EN 45004 or EN 45011 (EN 45001 to be observed for testing required) – explicitly refer to measurement uncertainty in conformity assessment.

More recently, it has become practice to refer to ISO/IEC 17025 [8] which also explicitly mentions measurement uncertainty as a technical requirement. This is also in line with generic product certification standardization, where for instance a new draft international standard [9] refers to this standard for product certification systems built on the testing of product characteristics, as well as requirements in connection with accreditation [10].

MID Module D. Quality assurance. Instrument manufacturers

"The manufacturer shall operate an approved quality system for ... final product inspection and testing of the measuring instrument ..." [11] is a requirement both in Module D but also other Modules D1, E and H which refer to the declaration of conformity based on quality assurance. An additional requirement is that "The quality system shall ... contain an adequate description of ...the quality records, such as the inspection reports and test data, calibration data, ..." [11].

"Very few directives refer explicitly to the quality system standards. However, a general reference can be found in Decision 93/465/EEC. Directives may lay down additional provisions for conformity assessment according to modules D, E, H, and their variants which require that compliance with standards EN ISO 9001, 9002 and 9003 is completed with supplementary elements. This is to take into consideration the specificity of the products for which it is implemented." [6].

While not explicitly mentioning measurement uncertainty in these MID Modules, current quality assurance standards such as ISO 9000 require measurement process quality assurance. The companion standard ISO 10012 [12] states:

"One of the stated management principles in ISO 9000 addresses the process-oriented approach. Measurement processes should be considered as specific processes aiming to support the quality of the products produced by the organization." .

Further in ISO 10012 §7.3:

"The **measurement uncertainty** shall be estimated for each measurement process covered by the measurement management system."

Measurement uncertainty and different types of instrument

A second reference to measurement uncertainty requirements is found in **harmonized standards & normative documents** when referred to in the various instrument-specific annexes MI-001 to MI-010.

MID Module B. Type examination. Notified body

For MID Type examination:

"For the specimens: the notified body shall... carry out the appropriate examinations and tests ... relevant document(s) referred to in Article 13..." [13].

Each of the 'relevant document(s)' referenced here by the MID treats specific metrological requirements differently, as reviewed by [14] and summarized in Annex A of the present Nordic Guide. Thus for example a notified body might refer to OIML R 49-2 when testing a heat meter as a MI-001 instrument.

Evaluating uncertainty in measurement

This Guide does not go into details about how to calculate measurement uncertainty but assumes that this is correctly evaluated, including *all stages* in the measurement process for conformity assessment. Individual sources of measurement uncertainty need to be considered from every element of the measurement system (object, instrument, environment, method and operator) used to test the measuring instrument subject to conformity assessment [15].

Uncertainties and decision-making in the MID

Metrological requirements in the MID and measurement uncertainty

Requirements on an instrument under test include reference specifically to 'allowable errors':

- '...error of measurement shall not exceed the maximum permissible error' [16];
- '...difference between measurement results ... shall be small when compared with MPE' [17] under both reproducibility and repeatability conditions.

In testing for real variations in intrinsic instrument performance, it is obviously necessary to allow for measurement uncertainty, $u_{measure}$, from uncorrected and unknown measurement errors associated with the measurement system used to evaluate the product (instrument).

General procedures about how to make decisions in conformity assessment in general in the presence of measurement uncertainty are not yet fully developed [18]. Three main stages in handling uncertainty in decision-making can however be identified:

- setting a limit on a maximum permissible measurement uncertainty;
- defining clear rules of conformity in terms of the location of an uncertainty interval to a specification interval based on the test characteristic; and
- allowing for risks due to uncertainty by for instance 'guard-banding' and/or agreeing on 'sharing' risks.

Measurement uncertainty intervals and specification limits

The approach in MID conformity assessment is in the first case to set limiting values on the measurable characteristic itself, often in terms of MPE, in addition to limits on measurement uncertainty MPU.

In deciding compliance, the test result, often expressed as an interval of measurement uncertainty $y \pm U$, has to be compared with the specification interval stipulated in the conformity assessment.

Rules still need to be developed to handle measurement uncertainty in decision making in a consistent and meaningful way. A recent international standard ISO 10576-1 [19] states:

"Conformity to requirements is assured if, and only if, the uncertainty interval of the measurement result is inside the region of permissible values"

and where specification limits are set without allowance for measurement uncertainty.

Treatment of uncertainty and risk close to a specification limit

Sharing risks

Recalling the central requirement for conformity to ISO 10576-1, which refers to how the uncertainty interval of the measurement result lies in relation to the region of permissible values, it is evident that clear rules for dealing with the "grey" zone where an uncertainty interval overlaps a limiting value are needed.

A number of different approaches to handling the risk of making erroneous declarations of conformity in this case exist. The risk of making erroneous declarations of conformity can be "shared" [20]. One common interpretation in legal metrology of the shared risk principle is illustrated in Figure 2. Another proposal for allowing for risk is to err in favor of the interested party, either the supplier or customer. In the ISO GPS geometrical measurement standard, for instance, in considering a situation where no previous agreement has been made between the supplier and the customer, then the principle is the following:

"The uncertainty of measurement always counts against the party who is providing the proof of conformance or non-conformance and therefore making the measurement" [21].

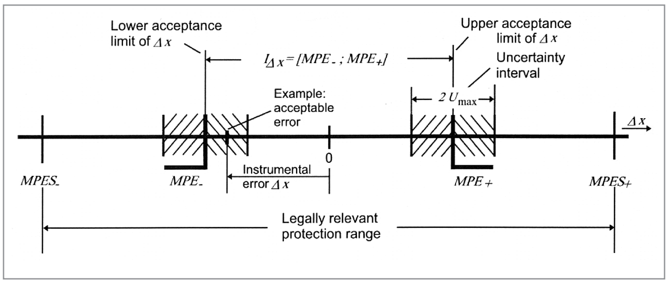

Fig. 2 Illustration of the decision criteria according to the classical verification approach.
MPE- and *MPE*+ are the lower / upper maximum permissible errors on verification;
MPES- and *MPES*+ are the lower / upper maximum permissible errors in service;
Δx value of the instrumental error;
$I_{\Delta x}$ error acceptance interval;
U_{max} = *MPU*

Risks and economic consequences of incorrect decision-making in the MID

It has been suggested that there is no "single universal rule" to follow when taking into account measurement uncertainty in a decision-making process, but rather "the rule should match the case" [23].

According however to Hutchins [24], in dealing with the "grey" zone where an uncertainty interval overlaps a limiting value:

"... for the majority who expect a simple 'good/bad' assessment, the 'indeterminate' status represents unhelpful over-complexity."

Some recent publications have calculated measures of risk associated with incorrect decision-making caused by measurement uncertainty [25]. End-users may however find percent probabilities difficult to relate to.

An interesting approach in this respect is therefore to associate certain costs, both to each measurement and to the consequences of making an erroneous decision based on measurement. The advantage of this approach is to weigh the consequences of unnecessary measurement effort against the consequences of incorrect decision-making.

This discussion of legal metrology in economic terms is in line with current trends as mentioned most recently:

"In future, consumer protection must look more closely at the economic consequences of the measurements made. This is why corresponding criteria of definition are required, the aim being to concentrate legal regulations on those measuring instruments where there exists a risk of errors which could result in prejudice to the consumer or in unfair competition." [26]

Optimized uncertainties - balancing measurement and consequence costs

Producer risks and costs by variables

When the uncertainty interval of a test by variables result partially (< 50 %) lies inside the region of permissible values, the cost E_{cf} of incorrectly rejecting a conforming instrument can be estimated as:

$$E_{cf} = \left(C + \frac{D}{u^2_{measure}} \right) \cdot \left[1 - \Phi\left(\left| SL - y_{measure} \right|, 0, u_{measure} \right) \right] \quad (1)$$

where measurement costs are D (per unit squared standard measurement uncertainty, $u^2_{measure}$) and effective consequence costs, C, as determined by the cumulative distribution function, ϕ, which expresses the probability of rejection in terms of the difference between the actual measurement result, $y_{measure}$, and the specification limit, SL, on instrument error. Costs rise from zero as the measurement uncertainty increases, following substantially the curve of the familiar 'operating characteristic' of acceptance sampling.

Consumer risks and costs by variables

The overall testing costs, E_{np} of incorrectly accepting by variables a non-conforming instrument when the uncertainty interval of a test result partially (< 50 %) lies outside the region of permissible values can be estimated as:

$$E_{np} = C\left[1 - \Phi\left(\left| SL - y_{measure} \right|, 0, u_{measure} \right) \right] + \frac{D}{u^2_{measure}} \quad (2)$$

In the so-called "optimized uncertainty (OU) methodology" [27], an optimum cost can be evaluated by balancing measurement costs, D (per unit squared standard measurement uncertainty, $u^2_{measure}$) against effective consequence costs, C, as determined by the cumulative distribution function, ϕ, which expresses the probability of rejection in terms of the difference between the actual measurement result, $y_{measure}$, and the specification limit, SL, on instrument error.

Consumer risks and costs by attribute sampling

In legal metrology, it is of considerable practical and economic importance to set and test compliance of a given type of measuring instrument to a specified limit of fraction non-conforming product. An analogous

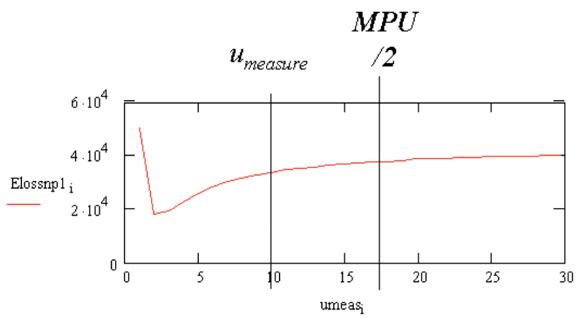

Figure 3 Consumer risk costs (€/a) as a function of standard measurement uncertainty (kg) for an automatic weighing instrument (MID MI-006, frontloader, capacity 3 tonnes)

optimized attribute sampling uncertainty methodology [28] is therefore developed in the present Guide in which costs of testing and sampling are balanced against the risks and consequence costs of exceeding a specification limit of fraction non-conforming measuring instruments in use in society.

Examples of application of these methodologies to typical decision-making in the context of legal metrology are given covering all 10 categories of measuring instruments ranging from water meters, automatic weighing instruments, to exhaust gas analyzers [29] covered by the MID.

Conclusion and future prospects

The present Nordic Guide intends to give a clear and informative review of the treatment of measurement uncertainty in legal metrology. It is hoped that it may also stimulate a more harmonized approach to measurement uncertainty in future instrument standards and normative documents. A principal aim would be that decisions in legal metrology would be based on the *same* principles of treating uncertainty in conformity assessment for every category of instrument.

At least the following principles should be followed:

1 MPU is the limit on the complete measurement uncertainty (including the resolution and repeatability of the instrument);

2 MPU ~ MPE/3 at each measuring point;

3 Shared risk principle: While in the first case limited to the specific framework of the MID, much of the guidance provided also finds application in other parts of legal metrology (such as subsequent verification of instruments).

A similar harmonization would be desirable even in the broader conformity assessment area when providing confidence for the consumer and supplier alike that requirements on products and services are met, specifically in sectors where such confidence is essential, such as health, safety, environmental protection and fair trading.

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REACTIONS

Legal metrological control over measuring instruments in use: current situation

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Abstract

The issue of subsequent verification as originally being a workhorse of legal metrology in protection of public interests is now in the spotlight of the metrology community, basically for two reasons: firstly, as the wave of major liberalization efforts in legal metrology in recent years slowly subsides, more attention should be paid to the implications for in-service operations over legally controlled measuring instruments having naturally a much larger impact on the protection of public interests.

Secondly, activities of manufacturers and other bodies attract more attention to this subject in an effort to secure more impact on these services, as was highlighted for example at the OIML session of the International Metrology Congress 2005 in Lyon, France.

This is why it is now urgent to explore the underlying concepts behind this matter in view of the current situation. This paper does this from the perspective and experience of a Government body responsible for operations of legal metrological control in one of the new EU member countries now exposed to a rather "hectic" development.

1 Introduction

The issue of uniformity and accuracy of measurements is as old as the first attempts by mankind to exchange goods and efforts in this regard have been an integral part of the development of any society since then.

In the course of this development it was more and more clear that a trading partner in any commercial transaction involving measurements has neither the skill nor the facilities to perform his/her own measurements or to check by him/herself whether measurements were made correctly.

It has therefore become a matter of public interest and it has been up to corresponding Governments to act here. The first logical step was to tackle the issue of uniformity, to overcome the fragmentation created by extensive use of local measures which was a crucial obstacle to an extension of trade and to a free movement of goods.

This was basically achieved by the Metre Convention in 1875 and the subsequent efforts to create more or less universal systems of measurement units (SI, Imperial). A uniform system of traceability of measurements was born, enabling the problem of accuracy to be solved as well. Apart from these technical developments Governments have had to take measures in their legislations and administrations to secure confidence in trade-related measurements in a transparent and impartial way. Originally, they were concentrated on consumer protection in trade; in the course of technological development other public interests have been added (health, safety and environment protection, fair law enforcement). This paper deals predominantly with measuring instruments used in trade and concentrates on metrological properties of measuring instruments - it has to be pointed out here that the way those instruments are used by their users (zero adjustment, leveling, "cold buying" and "warm selling", etc.) is important as well. A set of procedures to achieve the above mentioned goal was introduced which has gradually evolved into what is now called legal metrological control defined in the VIML [1] as follows:

legal metrological control (VIML 2.1): the whole of legal metrology activities which contribute to metrological assurance.

Note

Legal metrological control includes:

- legal control of measuring instruments,
- metrological supervision,
- metrological expertise.

In the above, legal control of measuring instruments is a generic term to designate legal mandatory operations to which measuring instruments as such may be subjected - historically, these activities were limited to so called assizing (Eichung in German - practically the same as what we now call "verification"), later they developed into what we now call type approval, initial and subsequent verification (for the definitions of these terms, see the Annex).

Type evaluation and initial verification are operations associated with putting instruments on the market and into their first use; subsequent verification is aimed at instruments in use. The problem is that pattern approval is frequently done with samples called gold-plated instruments, i.e. samples that have already been extensively tested by the manufacturer itself. And, even worse, there have been cases when samples with crucial components (for instance load cells) of a better quality, specially prepared for the purpose of pattern approval only, were submitted! The other extreme is that by using the competitive environment, e.g. in Europe, manufacturers press for as short a period of testing as possible. Naturally, nothing outstanding can usually result from such testing. This conclusion has been further supported by a recent exercise of the NMIA (Australia) in the post approval testing funded by the Australian Government where serious non-compliances were found in nearly 10 % of the samples (see [2]).

The other major source of non-conformities are the EMC tests with quite remote direct influence on metrological characteristics of those instruments in practice. As a result, regarding pattern approvals, there is a constant change of emphasis from third-party testing to a recognition of tests made by manufacturers on the basis of their quality management system. Initial verification can influence only the initial phase of the operational life of measuring instruments - therefore, it can be argued that operations associated with putting instruments on the market have a very limited, ever decreasing direct impact on the protection of public interests in legal metrology.

The important aspect here is that when introducing regulation covering measuring instruments Governments in the majority of countries have decided to charge an administrative fee for these operations: for type evaluation and initial verification to the manufacturers or their representatives, for subsequent verification to the users. This is by no means a natural move to make (with a dire consequences for the whole system - see below) even if the bodies concerned have to apply for them by law. There is a legitimate grudge against this on the part of the bodies concerned (expressed especially by users) who see no reason why they, as private bodies, should subsidize protection of public interests (consumer protection) in favor of and on behalf of the Government (the costs should be borne by taxpayers).

The alternative view is that the market penetration of legally controlled measuring instruments in any society is that deep that customers to their users are in their total de facto all the citizens – it is therefore in any event another form of tax. It has to be stressed here that these procedures have been introduced by Governments more or less artificially, in pursuance of protection of public interests; they are not common business (commercial) activities by their origin and nature.

By the original logic of the above, the procedures of legal metrological control were initially performed by specialized Government bodies. The scope was limited to measuring instruments such as nonautomatic weighing instruments (NAWIs - scales) and material measures (length, volume), later to automatic weighing instruments, with the advent of the automobile to dispensing pumps for fuels and taximeters - kinds of measuring instruments called generally (classical) weights and measures (W&M). These instruments are characterized by their subsequent verification being made on site and by their use for direct charging of payments (for a delivery of quantity of goods) to consumers (citizens). In the second half of the last century, after the advent of utility meters (water meters, gas meters and electricity meters), as the scope of legal metrology was widening, it became apparent that the area could not be served by Government bodies themselves and ways were explored and implemented in various countries to engage private bodies in initial and subsequent verifications under Government supervision, by way of authorization (licensing) to carry out those operations on their behalf. Such an approach has been applied especially to widespread instruments such as electricity meters, water meters, gas meters, etc. verified in laboratories so that simple and effective supervision over the authorized bodies could, in principle, be made.

At the end of the last century, pressures for important changes in the original set-up were mounting again. Firstly, the operations for manufacturers (type approval, initial verification) had to be made, in all the aspects with an exception of the decision on conformity, in a similar way as a normal service, i.e. to their satisfaction (delivery time, price, etc.). Here the responsible Government bodies being national monopolies and in a number of cases not being able to motivate their employees due to various limitations on their performance, were acquiring a reputation of doing rather badly (sloppy, bureaucratic and expensive service) to the growing dissatisfaction of manufacturers. Secondly, manufacturers had to go through the same procedure in every single country which was an obvious technical barrier to trade, especially in free trade areas like the EU. Under pressure from manufacturers and under the flag of hence popular liberalization this resulted in a deregulation consisting in a transformation of these legal control operations into a set of so called conformity assessment activities (CAAs). These were characterized by providing a limited number of options to be used by manufacturers and by direct involvement of manufacturers themselves: under certain supporting conditions they could carry out conformity assessment activities by themselves (self-declaration). The other CAAs were open to a multitude of technically competent bodies (in the EU, so called notified bodies), thus working in a competitive environment, with a universal recognition within a given free trade area if applicable.

The obvious advantage of the conformity assessment system is much higher flexibility for manufacturers; a disadvantage is that protection of public interests can be jeopardized (the commercial element in the operation of conformity assessment bodies has been severely strengthened). Since that time the Government authorities of legal metrology have been more or less involved, nationally or internationally, in streamlining and deregulating the legal control operations associated with putting instruments on the market and into use (type approval, initial verification). This does not reflect the fact that these operations are now of limited technical importance to the real protection of public interests (see above) and they can influence only the initial stages of the operational life of those measuring instruments. After all, instruments are, for the majority of their operational life, in use so that legal metrological control at this stage is much more important for effective protection of citizens/consumers.

In hindsight, the whole development started with operations conceived to effectively protect public interests but ended up with them playing a role of mere business expanding activities for a limited number of bodies (especially manufacturers of legally controlled measuring instruments and their representatives, and various servicing organizations associated with them).

The developments in the European Union can serve as a good example to demonstrate the above. The strategic move to overcome technical barriers to trade with products in general is called the new approach and the global approach - in 2005 their 20th anniversary was celebrated. The whole process was managed by DG Enterprise and Industry (DG EI) of the European Commission (EC) which was set up to eliminate TBT, to support business, competitiveness, etc. The whole process has been accompanied by much lobbying on the part of manufacturers´ associations. On the other hand, it has gone on completely unnoticed by DG Consumer Protection as if matters associated with it had no relevance to consumer protection. By the sheer logic of this arrangement matters of consumer protection have simply played no role in the whole process, DG EI has completely succumbed (maybe willingly) to pressure exerted by lobbying manufacturers. A more balanced approach could have been expected here - even if lobbying at the EC is sold to the outside world as nearly an official business for everybody, in reality it seems that the lobbyists with most vested commercial interests have always had the upper hand.

To an external observer it may appear that CAAs have always been around as some sort of business-expending activities for manufacturers. As to the celebrations, one would expect that at this moment the EC would consider it important to conduct a survey or analysis as to whether the new and global approaches, while eliminating TBTs and liberalizing towards manufacturers, have not compromised the protection of public interest on the way. As is demonstrated in [2] the reduction of testing activities being a result of liberalization is beginning to have a negative impact on the quality of products. With obvious advantages for some interest groups this will be an ultimate indication of the success of the whole process.

Now manufacturers surely have something to celebrate; the big question is whether European citizens have something to celebrate as well. It may well happen, like in some other cases (e.g. the BSE case), that European citizens will wake up one day to see that an effective protection against unfair measurements no longer exists, being hijacked in the meantime by the interest groups with the highest commercial interests.

While assigning this job solely to DG EI might appear strange it has to be admitted that this DG has been strictly following its mission: to promote business. It is only a zero involvement of DG Consumer Protection (DG CP) in these matters that raises considerable concern, as if being (unjustifiably) satisfied that things are under control by some sheer inertia from the past.

Instead, DG CP is fully engaged in doubtful efforts to protect European citizens against their own indifference or ignorance. Apart from the fact that only meeker results from these activities can be expected, this approach in a number of cases arguably violates the principle of *Caveat emptor* (buyer beware) to be applied in industrialized countries: protection by public means should be provided only in cases where consumers cannot protect themselves on their own. The reason for doing so may lie in sheer populism, but this is somewhat acceptable only in the case where a major drop in justified consumer protection does not escape attention, as apparently is the case of legal metrology at present.

As explained above, for various reasons the legal control operations associated with putting instruments on the market are both of limited direct importance to the protection of public interest in metrology and are frequently regulated by supranational bodies with TBT matters being of the highest priority on their minds. It is therefore worthwhile to pay more attention to and analyze in detail the situation in legal metrological control over measuring instruments in use (the term "verification" therefore means "subsequent verification" if not otherwise specified).

2 Arrangements used in practice associated with measurements in use (in service)

In principle, subsequent verification can assume the following two forms (VIML 2.16):

a) verification after repair is applicable to any measuring instruments under regulation: when seals are broken, be it a result of a failure or of a (more or less necessary) maintenance operation, the MI has to be reverified (to reinstate its original state). By its logic this type of verification is always more open to licensing of repairers (self-verification) to overcome the burdens of a demanding coordination between the repairer and the verifier. On the other hand, the impartiality is largely at stake here - normally, verification by an independent body only lasts until authorities succumb to pressure exerted by intensively lobbying manufacturers/repairers and drop the impartiality issue. Accreditation nowadays plays a catalytic role in that process even if it is established that accreditation does not place any real limitations on any body for impartiality reasons.

b) mandatory periodic reverification: mandatory verification in periods fixed by legislation.

Whereas the first form of subsequent verification is always present when instruments are regulated and has to be dealt with, the situation concerning the second form is more tricky. Various combinations of activities of legal metrological control to tackle effectively the protection of public interest apart from verification after repair are imaginable, currently basically three approaches (models) are used in practice worldwide in trade-related measurements:

1. Mandatory periodic verification of legally controlled measuring instruments charged to their users complemented by actions of metrological supervision (further referred to as the German model)

At the same time, all the activities are normally carried out by a single Government body (authority) in any given constituency. The fee to be charged for verification was originally an administrative fee[1] being an income of the Government budget; nowadays it is frequently a contractual payment (inclusive of a profit) being an income of the body charging it. The characteristic feature of this arrangement is that users cannot be held solely responsible for non-compliances with the regulations after being subject to a mandatory operation in fixed intervals for which they have to pay. Together with type approval and initial verification the whole complex system by itself should guarantee the continual compliance of those measuring instruments with the regulations[2]. This is a system which happens to have been applied predominantly in continental European countries; its origin could be traced back to German speaking countries (Eichung) and countries in their circle of influence. This system of legal metrology has been designed to be of a minimal burden to taxpayers - this is its obvious advantage but at the same time a bomb ticking under it (see below). In a relatively high number of OECD countries verification has been passed over to licensed (authorized) or accredited bodies either fully (France, Sweden) or only for measuring instruments outside W&M (Germany, Switzerland, Austria until 2004, Czech Republic, Slovakia).

2. Mandatory periodic verification of legally controlled measuring instruments not charged to their users (further referred to as the American model)

The scope of regulation is limited to W&M and measuring instruments are verified (inspected) in fixed time periods by (national or local) Government authorities. No fee is charged to the users in line with the argument that users of MIs should not subsidize any protection of public interests in metrology. The logical consequence is that the user is solely responsible for keeping his/her instruments in compliance with the regulations. The term "verification" is used here to retain some sort of unified terminology - it is clearly a combination of verification and supervision (which is sometimes called enforcement, sometimes inspection, adding to the confusion). In the current circumstances the obvious disadvantage of this system is its sole dependence on funding from public sources. These are growing scarce and the operation of authorities could be severely hit by cuts in budgets. Such a system is basically applied in the USA.

[1] The term "administrative" is aimed here not at the contents of the attached noun but its legal framework. E.g. here it is of secondary importance whether the fees covered the costs fully or partially, the term "administrative" means that the fees were of statutory nature decreed by the Government being therefore an income of the Government budget.

[2] The whole system was originally designed with aim to really provide this guarantee but in the course of development the amount of testing had to be reduced under pressure from manufacturers. The integrity of the system, if additional counter-provisions have not been employed, has therefore been relaxed so that sometimes we can speak only about a minimalization of the associated risk.

3. **Metrological supervision only (further referred to as the Dutch model)**

   It is a variation of the previous one where a Government authority (but it could be an executive agency or even a Government owned private body) would make a supervision over measuring instruments specified by the regulation (normally W&M) based on its own plan of inspections in the field. There is no fixed period of time to make an inspection, normally every measuring instrument is inspected once in four or five years. No mandatory periodic verifications are made, verification after repair being licensed to technically competent private bodies. Users are solely responsible for compliance of their instruments with the regulations in place and free to take any measures to achieve that. Such a system was constituted in The Netherlands in the last decade of the last century. Again, being financially dependant solely on public funding, the stability of this system is questionable under the current circumstances when public funds are under a severe squeeze almost everywhere.

Firstly, it has to be pointed out here that there is still considerable confusion concerning terms associated with metrological supervision which is sometimes also called enforcement or inspection - this terminology is not properly covered by the current version of the VIML. The first attempt to overcome this was made in the revision of the OIML Document D 9 published in October 2005 [3].

Secondly, it is important to look upon these matters from the perspective of historical development. At the beginning all the activities of legal metrological control had a character of state administrative tasks to be performed by Government authorities. In the course of historical development, due to progress in technology, the scope of legal metrology widened and numbers of measuring instruments of all kinds installed in the field were constantly growing. At the same time, the number of various servicing organizations being private bodies (installers, repairers) associated with the operation of measuring instruments has been increasing as well. At least for practical reasons, pressures were mounting to involve manufacturers in legal control operations associated with putting instruments on the market. The original Government authorities ceased slowly to be in touch with these trends, especially due to the various limitations imposed on them as integral parts of the Governments (separation of income and cost accounts, salary caps, staff caps, insufficient investments, etc.). Eventually, activities of legal control over measuring instruments (type approvals, verifications) thus became, so to speak, immersed in the network of all the associated activities with Government authorities struggling to keep pace with these developments and also with fast technological progress.

By the logic of this development their character was gradually pushed from that of an administrative task to mere conformity assessment activities (CAA) which have, strictly legally, a commercial nature even if performed in protection of public interest. The same development took place in testing as well. This gradual transformation of activities of legal control over measuring instruments can be symbolically illustrated as follows:

character of activity: public administrative task[3] → conformity assessment activity

charges: administrative fee → contractual payment

bodies: Government authority → Government executive agencies, private bodies

The change of character in the activities concerned has been supported by the fact that the decision on conformity is based on results of objective technical tests and measurements so that appeals, being normally an integral part of any administrative tasks, are much less relevant here. In the event of non-conformity the instrument is not verified until conformity is established by an adjustment, repair or by its replacement.

Thirdly, it is important to highlight the features of all these models and internal relations among the individual activities. It has to be pointed out that all the activities of legal metrological control were initially conceived with the aim to protect a public interest (especially to protect consumers) in trade related measurements, otherwise they would not exist, only their calibrations on request from the users will occasionally be made. Therefore, they were not originally designed to be used for expansion of business or for any other such purpose.

The classical approach in Europe is based on verification of measuring instruments in fixed periods of time as a mandatory operation charged to users. It follows that, on one side, it is a source of revenues to anybody charging those fees; on the other side it is a financial burden to businesses of their users. Normally, legally controlled measuring instruments form a small fraction of the property of any user so that the

[3] Again, the primary importance here is to stress that the activity was reserved to public area performed by public (Government) bodies only resulting in a decision about rights and duties of persons involved. The whole way how to deal with such decisions is normally given by legislation (appeals, etc.). It is clear that in this case the decision was a result of technical work (various tests) as well.

associated costs are rather negligible. Users of many such instruments argue against such a system on the grounds that they should not assume the costs of consumer protection. This is a legitimate argument - the introduction of administrative fees at the beginning was based on the fact that users definitely had some advantage over their customers, thereby handling the whole measurement by themselves. It could have been expected that this advantage would fade out with technological progress but actually just the opposite happened (see below). There might be these or some other reasons to drop periodic verification out of the system - such a move always meets with opposition from servicing organizations who consider themselves as top candidates for licensing of these activities to them. They always (self-servingly) argue that Governments in any form should get out of this "business" (under the banner of an expansion or support to business activities) but that periodic verification should stay. It can easily happen that any such arrangement might render the whole system ineffective from the viewpoint of the protection of the corresponding public interest (see below). Mainly, any action of metrological supervision in the area of W&M is in such a case upfront rendered ineffective: for instruments verified on site it is often difficult to clearly find out who (the user or the verification body) is to blame in case of any non-conformity.

Such actions would take place a relatively long time after the last verification so that they can blame each other - as mentioned above, if users are subject to verification fees then they cannot be made solely responsible for any violations. In case of any changes in the traditional system it is therefore more correct to drop periodic verification altogether and to embark on the Dutch model than just to pass it on to private licensed bodies. By taking this mandatory charged operation off the shoulders of users in this way a real expansion (support) to business could be achieved without compromising the protection of public interest.

3 Latest developments

As mentioned above the arrangements called the American and Dutch models are stable as long as the necessary funding from public sources can be secured. Unfortunately, this has now become rather a liability as can be demonstrated by the situation in the USA.

A proposal to Congress called Fair Measurement Appropriation had to be initiated by metrology authorities in the Federal States to earmark more funds (to create a special Federal grant program) to them to be able to guarantee uniformity of trade measurements and general confidence in the market throughout the USA. This situation is quite complicated despite the fact that a considerable 52.8 % of GDP in the USA is directly impacted by legal metrology regulations and their implementation in the field.

Whereas the situation in the American and Dutch models is after all fairly straightforward, problems being limited to securing the necessary public funding, the situation regarding the German model is much more complicated. With some simplification, this is explained by the fact that some charges for verification to the users of measuring instruments are in play here and various private bodies as stakeholders look upon them as a means to complement their portfolio of activities (services) to be offered to users.

The periodicity of subsequent verification, having been applied in the past nearly everywhere, was a prime reason for the rise and expansion of the associated servicing operations (maintenance, repairs) with approximately the same periodicity. Especially when the design of measuring instruments was based on mechanical principles, periodical repairs were quite justified due to wear and tear (balances). As a consequence, instruments were verified predominantly after repair which required close coordination with authorities responsible for verification - a kind of logistical nightmare.

A provision in the Law on metrology enabling a limited validity of repair marks after a repair until next verification (e.g. for three weeks these marks are legally equivalent to those of subsequent verification) is quite helpful here; this would enable a superior type of cooperation to be created with servicing bodies: they could just report to verification authorities where measuring instruments have been serviced and they can verify them with an advantage separately and independently at their own discretion.

On the other hand, in the course of development after the arrival of electronic devices, some user organizations required (direct) verification without any assistance on the part of servicing organizations which, in some cases, assumed knowledge of the adjustment of those instruments. The range of measuring technology to be served during verification has been constantly widening due to technological progress, etc., which required considerable investments in new measuring and transportation technology on the part of the verification authorities. Therefore, Government verification authorities appeared themselves at the cross-section of various, sometimes conflicting interests which could only be served in a suitable legal and economical environment for verification authorities. The traditional system of Government bodies with all the limitations and bureaucracy would sooner or later simply make the necessary large-scale coordination here unfeasible.

As explained above, subsequent verification as an activity has changed, as a result of all the recent developments, its status from an administrative activity to a conformity assessment activity having the character of a (special type of) service. The imperative under the present conditions is therefore a service-oriented approach in carrying out subsequent verification; efforts should be made to satisfy the needs and wishes of all the stakeholders (customers) in all the aspects with the exception of the decision on conformity itself. This is in line with requirements of modern quality management systems as laid down in ISO 9001:2000. To achieve such a considerable change in attitudes on the part of (original) verification officers is not an easy matter but it is nowadays indispensable.

Another matter is associated with the nature of subsequent verification as an activity. There are often disputes during conformity assessment in the context of the above as to whether verification authorities (if properly trained) are allowed to make an adjustment of a legally controlled measuring instrument when needed. This is basically a gray zone: the adjustment can be attached to both verification and servicing. Traditionally, it is stipulated that verification authorities should not be involved in any servicing operations (a traditional exception is weights) on measuring instruments (naturally the opinion of servicing organizations as well), on the other hand a technically similar operation of calibration is unimaginable without the closely and naturally associated activity of necessary adjustments.

In the past when a high frequency of repairs was needed, such a requirement was acceptable and justified on impartiality grounds but now that the real need for repairs is very low it would be highly impractical. After all, after many concessions granted to manufacturers involved in servicing it is justified to grant this kind of flexibility to verification authorities as well. A different matter is whether verification authorities can obtain any access to the necessary information and training.

Important developments have recently taken place in the area of servicing of legally controlled measuring instruments. A difference has to be made here between real repairs (as a result of a failure or of a nonconformity not rectifiable by an adjustment or a light maintenance) on the one hand and a necessary adjustment during the verification process and regular preventive (recommended or non-recommended) maintenance on the other hand.

Whereas the former should necessarily be done by the manufacturer or its authorized representative, adjustments as such could be attached either to verification (more logical) or to repair/maintenance (more often in practice) or to both but they can only be done when the necessary technical knowledge is available from the manufacturer. Light maintenance as such has usually been part of subsequent verification. Preventive maintenance has been the principal job of repairers (service organizations) of legally controlled measuring instruments - in some cases, as a result of the increased complexity of modern measuring instruments, preventive maintenance could only be done by manufacturers themselves but basically this depends on the availability of the necessary information and training. The resulting arrangements in practice depend largely on where the centre of gravity across all the activities associated with legally controlled measuring instruments currently lies and these matters are considerably influenced by the conflicting requirements of impartiality and complexity of the whole service (including verification).

The intensity of servicing was historically quite high as a result of high failure rates and of the necessity for adjustments for instruments designed on mechanical principles. The other natural reason was that especially manufacturers were looking for some continuous source of income from services around measuring instruments manufactured by them to complement a fluctuating income from sales.

As the first reason has been overcome by technological progress one would expect a considerable drop in the intensity of servicing but just the opposite is the case. It is a result of aggressive marketing of service contracts especially on the part of manufacturers and their authorized representatives despite a very low real need for any servicing. This can be demonstrated in the area of nonautomatic weighing instruments, NAWIs (scales), especially in the retail sector, in Europe. Here the manufacturers formed, in early nineties of the last century, an association called CECIP which embarked on a very aggressive strategy in this context. The first move was to minimize any actions of third party bodies regarding the operations associated with putting NAWIs on the market this has been achieved by way of a new approach EU directive on NAWIs, until recently **the only** effective new approach directive in the area of measuring instruments.

Secondly, they have made efforts to operate solely through a network of daughter companies as authorized representatives in individual countries. The technical documentation is separated into operational and service manuals so that any information on servicing including any adjustments is not readily accessible, which enables them to exercise very tight control over any release of technical information to the outside world. After each delivery a service contract is offered to the user based on fixed payments covering basically two operations: regular maintenance at fixed intervals and repairs with very short delivery times. It can be assumed that proprietary technical information is used on the part of manufacturers to persuade users to sign such contracts. The intervals for regular maintenance are said to be as low as six or even three months in the retail sector. It is clear to any technician with experience in metrology that a necessity of any maintenance that could not be carried out by users themselves is with the current state-of-the-art technology practically zero - any demand for maintenance is generated artificially by manufacturers themselves. If user instructions are followed during operations in the field, then the design of NAWIs resembles that of digital multimeters - their maintenance in six monthly intervals carried out solely by the manufacturer's representatives would be ridiculous.

As for repairs, when instructions for maintenance are pursued by users, the mean time between failures is now practically the same as that to replace the instrument due to its technical or moral obsolescence. The instrument is discarded as obsolete and replaced by a new one before any failure occurs (with the exception, for example, of mechanical printers, now anyhow obsolete, with no influence on metrological characteristics). These malpractices have reached their climax in the chains of most super- and hypermarkets: maintenance intervals as low as three months are reported and verification fees themselves can form only ca. 3 % (!) of the fixed payments to servicing organizations (when some necessary adjustments are carried out by a verification authority the figure rises to about 5 to 10 %).

Here almost every chain is served internationally by an individual European manufacturer of NAWIs - these contracts are fixed centrally on a supranational level. It is anybody's guess to form his/her opinion as to whether this is an honest and fair way of conducting business but it is highly surprising that only the hypermarkets, well-known for their low-cost practices, are on such a "spending spree". It is clear that as a result of any major change in the arrangements concerning subsequent verification these lucrative contracts will be under attack. On the other hand, some trends are now working against manufacturers of NAWIs themselves and are hitting them severely - there are three major application areas for NAWIs up to 50 kg:

a) Big retailers: present fixed contracts are that lucrative that simply cannot sooner or later escape attention and fall under scrutiny of whoever has a stake here;

b) Small retailers who are financially squeezed by the big retailers will sooner or later find that any servicing is not necessary;

c) Industrial companies: normally NAWIs form a fraction of measuring instrumentation that has to be metrologically served either by calibration or verification. A modern trend here is outsourcing of these services to specialized calibration outfits; servicing organizations for NAWIs can usually provide services only for scales which more or less disqualifies them.

The above mentioned is corroborated by experience from the operation of the Czech Metrology Institute (CMI): for a couple of years now scales are serviced (verification + occasional adjustment) by CMI for two major users who themselves required no up-front involvement of servicing organizations in these operations and everything has been working to mutual satisfaction since the outset.

In the logic of the above manufacturers of retail NAWIs, after getting their way in operations associated with putting instruments on the market, they would like to achieve the same regarding the only activity outside their portfolio which is subsequent verification in all its forms. One is under the impression that they will never be satisfied until nobody other than themselves will ever touch NAWIs manufactured by them during the whole operational life of those instruments.

At the same time, retail NAWIs are one of the most sensitive kinds of measuring instrumentation for consumer protection and at nearly any stage no third party will thus be involved. This is even less than is normal in the non-regulated area of metrology and hardly acceptable to consumers. It would be a great paradox that consumer protection in this area will be licensed to bodies with such a history of aggressive pursuance of their commercial interests without any third party intervention. This strategy was officially presented (in an implicit form, but explicitly in the discussions) by CECIP representatives at the OIML session of the 12th International Congress of Metrology in Lyon in June 2005, even if one can argue that the current mature situation, taking all the information into account, might prove to be, after all, the most comfortable for manufacturers.

Nevertheless, a couple of matters should be taken into account here. Firstly, the idea of CECIP that it will be practically only manufacturers themselves who will do the job (after all, they have already cultivated the field for some time with service contracts) is a vast breach of any sort of impartiality principle which can easily backfire to regulators after consumers become aware of it in full. If the impartiality principle is consequently applied in "privatizing" verification then this will be the end of the current comfortable situation not only for verification authorities but for manufacturers and their representatives as well. Newcomers to this business (e.g. TÜV in Central Europe), equally aggressive as manufacturers of NAWIs, might enter the field and take all the balls away. It has been already proved above that this would not be of any support to business and the argument of liberalization sounds hollow as well if the impartiality principle is not applied: a monopoly of the current verification authorities will be just replaced by a quasi-monopoly of manufacturers over instruments manufactured by themselves, giving them even more leverage over users than now.

An additional undesirable development will be cherry-picking on this operation: private licensed bodies are only interested in those sectors of legal control where their profit can be maximized (the geographical and technical areas with the highest density of scales); it would no longer be possible to guarantee the current unified verification fees in all the geographical regions. For example, after such a change in Sweden, due to unfavorable geography, 80 % of scales, predominantly in rural areas, remained unverified for a long time which is tantamount to a complete disruption of the whole system. After all, the traditional system is much more favorable for the Governments on the financial side: considerable savings can be made on any type of metrological supervision as this can be carried out together with subsequent verification while the officers are on the move in the field.

Probably the most important argument of all, the creation of a competitive environment among verification bodies, will make them dependent on commercial interests which would completely suppress any consumer protection (see below). Therefore, as already mentioned, it would be better to change the system to the Dutch model (no periodic verification).

It is naturally highly important to analyze modern trends in frauds associated with measuring instruments. Frauds on instruments based on mechanical principles in use, especially an adjustment outside maximum permissible errors, were effectively eliminated by the introduction of subsequent verification, at least on instruments where the access to their measuring elements could be sealed. With the arrival of electronic instruments opportunities for fraudulent manipulations increased - the most popular method is called "turbo", a device which adds pulses at the output from the measuring transducers to simulate a higher quantity delivered. Such frauds have been identified on taximeters in a number of European countries including in the Czech Republic (Prague) and on fuel dispensing pumps (in Spain near Madrid). These devices are difficult to detect during normal verification as they can be covertly switched on and off by the users. Their installation requires a cooperation of users with repairers - another reason to hesitate whether such bodies, being surely front runner candidates, should be licensed to take over subsequent verification aimed at protecting the public interest. It is clear that subsequent verification is nearly powerless in eliminating such malpractices, which might be one reason to contemplate the Dutch model.

Unannounced actions of metrological supervision based on purchasing the goods in the field by inspectors pretending to be normal customers are the only remedy to suppress it. Therefore, nowadays periodic verification, if applied, has to be accompanied by a fairly high amount of metrological supervision otherwise we cannot speak about an effective protection of public interests.

However recently, another kind of fraud is significantly rising, at least in the Czech Republic: manipulation with errors within the mpe. This is becoming ubiquitous in the area of fuel dispensing pumps at gas (petrol) stations. It has to be pointed out that under current conditions when such frauds would not normally be covered by laws on metrology they are perfectly legal despite considerably hitting consumer's purses - they can be called "soft" frauds. They have been enabled by progress in technology: metrological characteristics of measuring instruments are now stable enough, making such soft frauds feasible and worth attempting. Naturally, the mpe's could be continuously adjusted in legislation to keep pace with the quality of modern technology making this "fraud" far more difficult. However, nowadays there are no signs of any efforts (e.g. by the OIML) in this direction, not to mention the fact that any such motion would arguably meet nearly universal opposition from all the interested parties with the exception of consumers - at least considerable delays can be expected here.

Furthermore, in the current globalized world, such a change would have to be made in an international normative document such as in an OIML Recommendation, rendering this nearly impossible. In the case of fuel dispensers with mpe's of 0.5 % for normal fuels this means that the error is set to a level very close to the tolerance limit in favor of the user of the fuel dispensing pump - of course, this is done in close cooperation between repairers and users at the demand of the latter and could be done any time, not merely immediately prior to verification.

We have had an example of a major distributor of fuels who did this at its petrol stations just six months after the last verification of the dispensing pumps (the reverification period being two years). These soft frauds are much more attractive to users than any reduction in verification fees as a result of e.g. liberalization in this field. The authorities in the Czech Republic have made an effort to counter this by issuing an internal guide for the inspectors to make sure that dispensing pumps are adjusted into narrower mpe's of 0.5 when they are adjusted; this is naturally only a halfhearted attempt to bring the situation under control but it is not supported by legislation (users can decide to have them adjusted any time, they do not care about any additional verification fees). Now everybody can calculate what it amounts to for an individual consumer, or in total for all the consumers. This matter does not stop at the cited ca. 0.5 %: when actions of metrological supervision are carried out between verifications; the errors found have to be compared with the so called expanded mpe's (usually 2 × mpe at verification) to take into account effects of normal wear and tear over time.

Now if authorities abandon subsequent verification by "privatizing" it to licensed bodies and confine themselves to mere supervision over instruments in use, this could drive these soft frauds into new highs of nearly 1 % and would be a direct consequence of the competitive environment: licensed verification bodies would *like* to satisfy the wishes (the author is purposefully avoiding the word "needs" here) of users of whatever measuring instruments are under consideration; for them any such "soft" fraud is much more lucrative than any reduction of verification fees due to competition. Surely, to increase the revenues by 0.5 up to 1 % on the part of retailers without any costs is tempting enough not only in fuel distribution (and in future the situation will be much tighter) but e.g. in weighing as well. Therefore, whether anybody likes it or not, a freedom from commercial interests (in other words, a monopoly of an authority or a body linked to the local Government) is the only way to bring this kind of fraudulent behavior under control.

This same type of argument is used to justify the national monopoly position of accreditation bodies - it can well be argued that the reasons are much stronger here than in accreditation. Everybody is aware of the traps presented by monopolies but under certain conditions it is manageable. Another aspect of this matter is that any legal provisions aimed at minimizing these soft frauds can effectively be enforced, until the mpe's are changed in the legislation, only by application of subsequent verification: the check that the error after an adjustment complies with whatever is stipulated by law can only be made immediately after the adjustment and the best tool for this is subsequent verification.

The replacement of mechanical measuring instruments by electronic ones over the last decades of the last century is an important technical factor here as well. Eventually, dedicated electronic designs are now more and more replaced by freely programmable devices based on PCs - a part of this software can naturally be used for evaluation of the measurement results, so it should be put under legal control. Projects are in progress to prepare suitable guidance documents as a basis of subsequent standardization, for testing and protection of this part of software both at global (OIML) and regional (WELMEC) levels. Apart from having clear benefits, the logical trend to replace more and more functions of legally controlled measuring instruments by software opens the door to particularly dangerous frauds: they can be switched on and off remotely via wireless communication networks.

Finally, an influence in the progress of technology should be explored. It would be an illusion, under the current pace of technological development, to think that in a couple of years it will still be necessary to put a weight on a scale to perform a verification - some more electronic ways of achieving legal metrological control over instruments in use can be envisaged, such as an electronic surveillance system which could be based on the wireless transfer of data to regional hubs for computer processing from the so called built-in "golden" standards being installed in legally controlled measuring instruments (suitable transducers such as the present load cells in NAWIs, or flowmeters in fuel dispensers). The output signal from these standards, which is proportional to the delivered quantity, could be continuously compared with the totalized quantities charged to customers which would lead to a round-the-clock surveillance over the correctness of commercial transactions without any human interaction (subsequent verification would of course no longer be required) when this makes economic sense due to progress in technology.

This would be an ultimate remedy against software-based frauds as well. Such golden standards would have comparable metrological parameters to the measuring transducers in the instruments with relatively long maintenance periods (no moving parts, no obtrusion to flow of media) which would be completely inaccessible to users and repairers; they would be easily exchangeable black boxes completely in the hands of surveillance authorities. They need not necessarily be of better metrological characteristics than the "working" measuring element in the instrument under investigation - their primary purpose would be to prevent major (especially software) frauds and to provide risk assessment for targeted surveillance actions. Such arrangements would fully justify the use of the Dutch model (no periodic subsequent verification) with a significant reduction in operational costs to users.

For example in the area of fuel dispensers the ideal transducers might be ultrasonic flowmeters (today they have inferior metrological characteristics) or mass flowmeters (today they are still relatively expensive). At the same time another black box can continuously monitor the quality of delivered fuel. The instruments with those built-in golden standards would be more expensive to purchase but the long term operational costs might be eventually the same or lower even if a fixed fee would be charged for occasional calibrations of those standards (their metrological characteristics could be evaluated by software to optimize the recalibration intervals). Alternatively, the operation of such a system could be funded from public sources. As such an on-line surveillance system would not directly benefit manufacturers and servicing organizations (rather the opposite) but users and consumers, these changes would have to be supported by regulations on a global level, e.g. OIML Recommendations.

4 Summary

A number of conclusions can be drawn from the above. Firstly, the fact if that those Government authorities that are now authorized to make subsequent verification in the traditional way can survive in the current demanding conditions as outlined above, then the following measures have to be taken:

1) To separate administrative activities from those of conformity assessment: a direct consequence of the presence of administrative activities is that the body under consideration should have a status of a Government body and it is a customary fact that various limitations (separated income and cost accounts, salary cap, staff cap) are attached to its operation. As a result, such bodies naturally cannot operate in a business-like way as is now required, they are not able to motivate their employees and adjust to changing external conditions. Finally, they appear to be out of tune with the surrounding reality and have to drop out of their business. Things are further impaired by various austerity measures imposed by the Government where, surprisingly enough, the revenue side of the matter is not taken into account. It is clear that in federal administrations this is rather difficult, but still no more indispensable.

2) To take steps to be, ideally, completely independent of servicing organizations in terms of necessary technical instrumentation or transportation equipment - if they are not, authorities slowly lose their grip over their statutory activities and become more dependent on servicing organizations and not able to keep pace with technical development and with the widening scope of subsequent verification. Sooner or later, servicing organizations start arguing that their presence in the system is redundant.

If the outlined transformation into, at least, an executive agency type of organization with a global budget is not made, then the justified needs of the stakeholders (users, servicing organizations) cannot arguably be satisfied in the long term. Justified criticism (especially on the part of servicing organizations) will grow, resulting in pressures to "privatize" subsequent verification. Anyhow, this transformation is an absolutely necessary (but still not sufficient) condition for traditional authorities to survive. On the other hand, after such a transformation, to "privatize" subsequent verification would be an extremely unwise and unfortunate irreversible decision to make, due to a number of reasons outlined above, on the part of any responsible Government.

It has to be pointed out that this arrangement does not have the relatively comfortable character of "natural monopolies" such as in the energy sector - the activity can easily be passed on to private licensed bodies so that these authorities have to do their best to serve all the customers properly, and are under constant pressure.

The situation with existing frauds at the end of the last century seemed to support the idea of dropping periodic verification completely out of the system with a number of benefits for the largest interest group in this business, i.e. the users of legally controlled measuring instruments.

Actually, periodic verification with its associated lower intensity of metrological supervision was not able to cope with existing frauds (turbo) and was an unsubstantiated burden to users - it seemed more and more obsolete accompanied by a sloppy performance of traditional verification authorities such as Government bodies, making life difficult for servicing organizations. As demonstrated above, however, the right liberalization step to make in this situation was to drop periodic verification (the Dutch model), and to pass it over to private bodies, especially servicing organizations (led by manufacturers in some cases), who are the most heard and connected out of all the interest groups.

With the advent of soft frauds (manipulation of errors within mpe's) the situation has changed: at the moment there is no other more effective, if not the only one, way to tackle it (naturally, if supported by legislation) than by way of subsequent verification, i.e. by an immediate independent check of the correct adjustment of the measuring instrument under maintenance or repair. Any subsequent findings in this respect by way of metrological supervision are simply legally irrelevant due to objective changes of the metrological characteristics of those measuring instruments caused by normal wear and tear over time in operation. The system of unannounced inspections (the Dutch model) is not able to cope with this type of soft frauds for the following reasons:

a) By being based on in-service surveillance the compliance checks have to be made against the extended mpe's, which actually widens the scope for such frauds;

b) This type of fraud can only be prevented when an impartial authority either directly makes adjustments on measuring instruments or supervises their performance by a repairer as is the case in subsequent verification carried out by independent bodies.

There is a renaissance of subsequent verification carried out by independent bodies and in those countries in which it has survived, the Governments should not get rid of this useful tool at this moment. It therefore appears that the transformed German model of legal metrological control over instruments in use in the area of W&M is, after all, the most economical solution for Governments covering all the necessary angles, especially an effective protection of public interests. Naturally, along with technological progress, ways to replace human intervention by electronic surveillance should be explored.

In this time of ever-increasing energy prices the current state of affaires in legal metrology characterized by guaranteeing superficially laid-down mpe's (especially those in-service) with instrumentation sometimes of a low quality as a result of globalization, will not be tenable in the long term. Users and customers, after awakening to all the implications of low quality measurements, will ask for a better service, including some guarantees of correct measurement results within the mpe's. Another breakthrough can be expected in the maintenance (servicing) area: hardware functions of measuring instruments are being quickly replaced by software functions which can be serviced remotely by way of modern communication networks.

The amount of traditional on-site servicing is therefore bound to drop significantly, reflecting the fact that it is nowadays rarely done for strictly technical reasons. ■

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Annex
Definitions of terms

conformity assessment (ISO/IEC 17000:2004, par. 2.1.1):

"Activity that **provides demonstration** that specified requirements relating to a product, process, system, person or body are fulfilled."

This new definition of CA is absolutely correct and clearly contradicts the definition of the term "calibration" in the VIM:

calibration (VIM 6.11):

"Calibration is a set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument, or values represented by a material measure or a reference material, and the corresponding values realized by standards."

It is clear from this definition that during calibration:

- *no requirements, especially in terms of limits or tolerances, are in most cases available (also no written standards are available either);*
- *no decisions are made in the process or in the calibration certificate;*
- *no assessment whatsoever is made during the process.*

As a result, calibration is not a CAA. Pure testing labs confined to issuing a test report only and not involved in any decisions should not be a CA activity either - see the definitions:

testing, test, testing laboratory (ISO Guide 2, par. 13):

"testing is an action of carrying out one or more tests"

"test - technical operation that consists of the determination of one or more characteristics of a given product, process or service according to a specified procedure"

"testing lab - laboratory that performs tests"

As a matter of course, activities of legal control over measuring instruments as defined in VIML:

type approval (VIML 2.6): decision of legal relevance, based on the evaluation report, that the type of measuring instrument complies with the respective statutory requirements and is suitable for use in the regulated area in such a way that it is expected to provide reliable measurement results over a defined period of time.

verification of a measuring instrument (VIML 2.13): a 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.

initial verification (VIML 2.15): verification of a measuring instrument which has not been verified previously.

subsequent verification (VIML 2.16): any verification of a measuring instrument after a previous verification and including:

- mandatory periodic verification;
- verification after repair.

Note

Subsequent verification of a measuring instrument may be carried out before expiry of the period of validity of a previous verification either at the request of the user (owner) or when its verification is declared to be no longer valid.

are conformity assessment activities.

metrological supervision (VIML 2.3): control exercised in respect of the manufacture, import, installation, use, maintenance and repair of measuring instruments and/or in respect of their use, performed in order to check that they are used correctly as regards the observance of metrology laws and regulations.

CONFORMITY ASSESSMENT

Conformity assessment and metrology

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1 Introduction

Conformity assessment is defined as the demonstration that the specified requirements for a product, process, system, person or body are fulfilled [1], and its field includes such activities as testing, inspection, certification, and accreditation of conformity assessment bodies.

Also defined are the terms **requirement** as a stated need or expectation, generally implicit or obligatory, and **specified requirement**, which is declared, for example, in a document, and could be a product standard and specifications or society-stated legal regulations of another kind [2].

In this paper we try to approach the topic of conformity assessment when the "specified requirements" are metrological requirements related to a product, process, or system, or when product conformity can only be assessed through metrology-related actions.

2 Developments in conformity assessment

Conformity assessment aims to provide confidence in the quality of the assessed item, and since each of its techniques and activities contributes to that confidence they can be represented as a pyramid, on whose top we find the most complex and important activities to achieve such a desired level of confidence [3].

Conformity assessment has a functional approach [1] through three functions that satisfy a need or a request to demonstrate that specified requirements are fulfilled, namely:

1 Selection: This involves planning and preparation activities to gather or provide all the information and the necessary inputs for the following function of determination.

2 Determination: Activities undertaken to acquire complete information about the fulfillment of requirements specified by the object of conformity assessment or its sample.

3 Review and attest: The final stage of verification before the important decision on whether or not the object of conformity assessment has been shown to reliably fulfill specified requirements, ending with a statement based on a decision taken after the review that the specified requirements have been fulfilled.

Such demonstration can strengthen the statements that the specified requirements have been fulfilled and make them more reliable, thus providing more confidence among users [1].

In general, the standards used are "specified requirements", since they represent a wide consensus of what is pursued in a given situation. As a result, conformity assessment is often deemed to be a standard-related activity [1].

Conformity assessment involves various levels, all of which are committed to product quality. In this connection, a laboratory is conducting an internal conformity assessment when it pays attention to the fulfillment of requirements that prove its competence, as in the case of a **supplier's conformity statement** which is made by the supplier himself to provide a certain confidence but falls short of a certification process [3].

Conformity is also assessed when a given product is found to fulfill the requirements specified in normative documents concerning quantified parameters and tests, and the relevant certificate is issued. **Certification** entails highly complicated processes and decisions and many demanding requirements laid down in relevant International Standards and Guides and periodically evaluated by the accreditation body, and also because of its third-party status that makes it independent from the manufacturer and the buyer, free of any conflict of interests in its assessments, and therefore highly reliable [3].

As conformity assessment bodies, the testing and calibration laboratories must prove to be competent in the specific activities that they state. The results issued by them will be recognized or credible if they meet international recommendations and are assessed by recognized accreditation bodies such as the National Accreditation Body of the Republic of Cuba (ONARC).

Consequently, the accreditation body is assessing conformity when it evaluates the competence of a laboratory to work in a given nomenclature.

Accreditation provides the necessary confidence that the conformity of a product, service or management system has been assessed with the sufficient degree of objectivity, impartiality and competence [3].

In this regard it is important to mention **peer assessment**, defined as the conformity assessment system applied to a body by representatives of other bodies that are members of, or applicants to, an agreement group [1], and it is one of the most important definition activities in the field of metrology.

Conformity assessment is present in each of the stages of a product's life-cycle [4], shown in Fig. 1 with remarks made by A. El-Tawil.

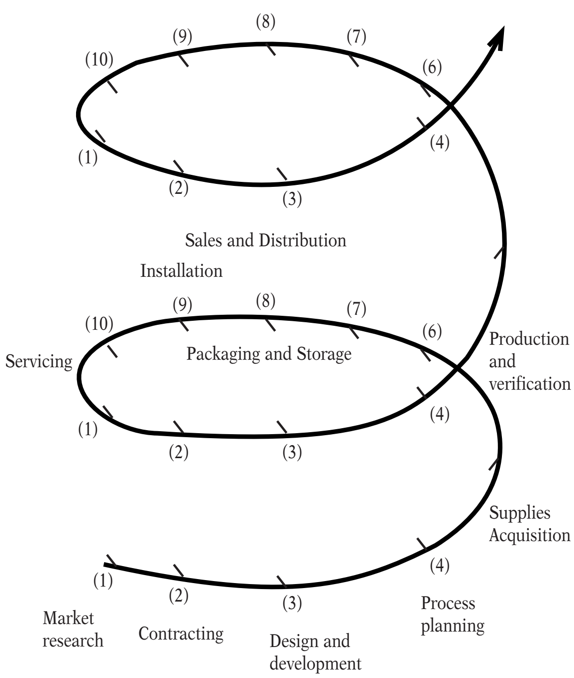

Fig. 1 Product's life-cycle

3 Metrology and trade

Measurements have to become international, for the world's economy is defined by worldwide trade [5]. Today's global economy depends on safe and reliable, internationally accepted measurements and tests.

Add to all this that recognition of the role played by both metrology and measuring and testing systems as the mainstay of social and economic development is growing at international level and will help eliminate TBTs, mainly in developing countries [6].

Today's metrology is based on broad and close cooperation and collaboration worldwide. It is no longer possible today for metrology bodies to carry out their work by themselves and only with their own resources. They need to share resources and services with neighboring countries, and each national body must specialize in specific, complementary technical fields and rely on bodies from other countries for other fields as the only way to fulfill their assignments. International harmonization, mutual confidence and mutual recognition among legal metrology bodies and authorities are needed to facilitate trade.

A commercial transaction is a typical example of this [7]. The clients and suppliers become involved in it through contractual relationships in which product quality is evidenced by means of a guarantee of its conformity to the standards, and the confirmation of conformity of the measuring instruments used during the transaction to assure that they offer correct indications is also recognized.

The method used to decide whether an instrument meets legal metrology requirements has a major impact on the accuracy it can achieve. The decision about such conformity is made through two approaches: a classic one where uncertainty is not taken directly into account, and a more modern approach in line with industrial decision-taking rules to provide conformity with specifications [8].

An effective measurement management system assures that both the equipment and the measurement processes are fit for their intended use, so it is important to meet product quality objectives and manage the risk of obtaining incorrect measuring results. The methods used for the measurement management system range from basic equipment verification to implementation of statistical techniques to control the measuring process [9].

The checking of measuring instrument conformity to ensure that they give correct indications is based upon legal regulations using specific methods for each field, for example: in the case of industrial metrology, periodic calibration of measuring instruments is used according to the Measurement Management System [9]; in the case of software, the guidelines for the application of ISO 9001:2000 to software [10]; and in the case of legal metrology, pattern testing and subsequent instrument verification according to legal regulations are used [8].

The elements to verify legal conformity of an instrument include [8]:

- Qualitative tests;
- Calibration-related quantitative tests;
- Assessment of qualitative and quantitative tests to make sure the instrument meets the legal requirements; and
- A decision to approve the instrument if the assessment is satisfactory and apply the relevant marks and certificates, for instance, the verification mark.

We must point out that using legally verified instruments within the framework of Quality Management sometimes poses a problem since only the maximum permissible error is established for instruments without an explicit statement about uncertainty, which makes users feel concerned about equivalence and the measurement results given by calibrated and verified instruments [8].

Not only customers and suppliers play a role in commercial transactions, but also, and decisively, International Organizations that rule over their respective fields and one way or another overlap their interests to make sure these transactions are made with the expected rigor and quality [11].

These Organizations strive to attain worldwide harmonization of testing requirements and procedures, especially in the field of legal metrology, to implement a global measurement system for the benefit of mutual recognition in trade [12].

In a Global Measurement System, tasks are undertaken according to a single worldwide approach. For instance: similar, internationally-accepted physical units, standards and procedures, and similar calculations to establish measurement uncertainty [12].

The Global Measurements and Tests System includes four essential elements [12]:

- A uniform system of harmonized national regulations in the field of legal metrology;
- A uniform system of harmonized standards in the fields not regulated by metrology;
- Worldwide recognition of the traceability of measurement results according to the International System of Units (SI); and
- Worldwide harmonization of requirements related to the competence of testing laboratories and certification bodies.

In this regard, the OIML and the World Trade Organization (WTO), as well as the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), the International Laboratory Accreditation Cooperation (ILAC), the International Accreditation Forum (IAF) and the International Committee of Weights and Measures (CIPM), lay down provisions which directly influence the performance of both the manufacturers during product development and the importers and traders [12] and help this System as follows:

- The WTO and the OIML harmonize legal regulations;
- ISO and the IEC harmonize standards;
- The CIPM harmonizes traceability to SI; and
- ILAC and IAF harmonize the competence of testing laboratories and certification bodies, which is shown in detail in Fig. 2 [12].

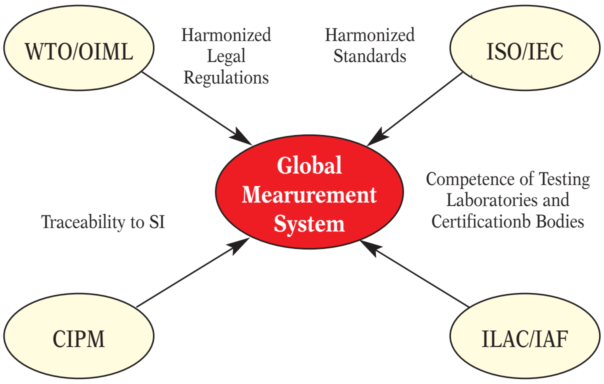

Fig. 2 The four elements of the Global Measurement System

Among the specific issues raised by these International Organizations are [11]:

- Use of standardization- and metrology-related international Recommendations;
- Rendering standardization and metrology measurements compatible in various countries;
- Adoption of the International System of Units (SI) for commercial purposes;
- Harmonization of accreditation procedures; and
- Establishment of National Centers to answer any questions that could arise among countries during trade.

In this regard, the OIML also produces Recommendations for measurements in the various fields of application of legal metrology, as shown in Fig. 3, to guarantee an adequate level of reliability concerning measurement results and thus facilitate mutual recognition and eliminate TBTs.

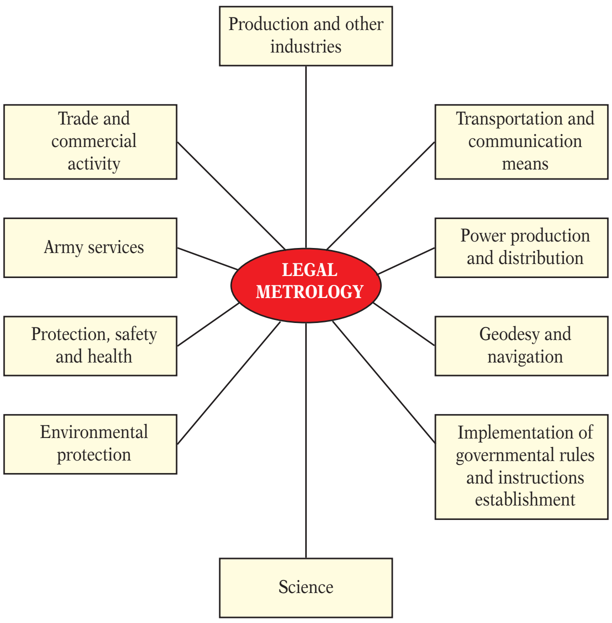

Fig. 3 Fields of application of legal metrology

Among the regulations linked with this topic, we can point out OIML D 19 on Pattern evaluation and approval [13] which assesses the conformity of instruments to their patterns and plays a major role in laying down guidelines to know or specify the following:

- Terms and definitions in this field;
- Instruments submitted to pattern approval;
- Pattern approval processes;
- Pattern evaluation plan;
- Pattern evaluation report; and
- Pattern approval-related decisions.

The results of conformity assessment or simply its mandatory character usually become TBTs, which can be tariff or non-tariff barriers. The latter are divided in turn into technical and non-technical barriers.

Three types of TBTs can be distinguished [14]:

1 TBTs built upon legal public-oriented requirements for security reasons in industry, traffic and consumer protection, health and the environment, etc.;
2 TBTs resulting from the implementation of national standards, for instance: design, operation, quality or product compatibility standards; and
3 TBTs arising when the results of national tests or certification procedures of the producing country are not recognized in the country of destination.

A significant contributor to eliminate TBTs in the field of legal metrology is the OIML Certificate System to better satisfy producers' needs for an approved pattern and to develop procedures for the recognition of acceptance or equivalent.

To date, 41 categories of measuring instruments are covered by the System and 1562 OIML Certificates have been issued for a total of 415 Recipients [12] since 1991 (figures as at end May 2006).

Every country works to eliminate problems that might become TBTs. Even a poor metrological infrastructure in developing countries, or the differences between standards or testing methods for product conformity assessment, could be a TBT, as happened when African countries were unable to prove the conformance of fish they wanted to export to Europe and suffered considerable losses as a result, or the disagreements between Canada and the European Union due to their different methods of defining paper whiteness [15].

Any problems that can become a TBT may be notified by the WTO at the earliest stages of product development or requirement modification for products already in the market. In fact, there are WTO notifications [16] on draft national documents which, if not known or recognized by trading partners, could eventually become technical barriers.

For instance, the US Food and Drug Administration which modified the regulation on bottled water quality regarding the requirement "permissible level of arsenic concentration".

In El Salvador, the minimum specifications regarding quality and testing methods of oil products such as asphalt and asphaltic emulsions, among others used in pavement construction and treatment are reviewed, as well as other products such as civil aviation kerosene and fuel.

In China, regulations are periodically updated and made available for the metrological supervision of prepackaged products.

Mutual recognition of Certificates in international trade is an advantage for society and for the manufacturers of measuring instruments in particular, since they can dispense with testing and conformity assessment. Ideal for a manufacturer would be worldwide acceptance of a Certificate for a test carried out once by a selected laboratory, as shown in Fig. 4 [12].

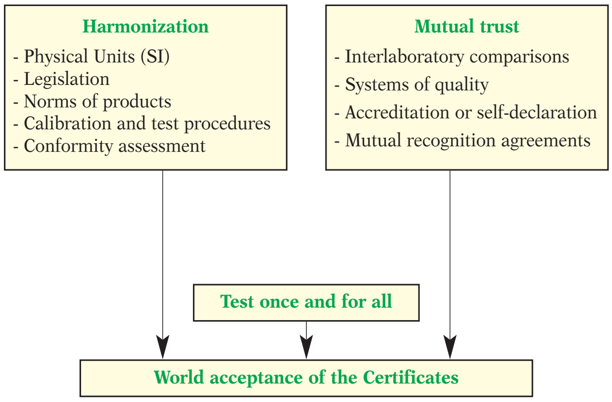

Fig. 4 Steps for the Global Measurement System

4 Harmonization and projections

International Organizations such as the OIML, ISO, the IEC and others define and implement the main concepts for harmonizing metrological policy [5].

No activity in any country can be isolated from the competition and influence of the rest of the world. The development of international trade has allowed industrial merchandise and goods to circulate worldwide in spite of tariffs and technical barriers, and global competition has become a fact. No industry anywhere can overlook whatever competitors in other countries, even in distant places, are developing and supplying. The TBTs are a fallacious protection for industry because they are a burden imposed on customers, who demand the best products and services available [17].

Developments in technology have significantly changed every aspect of economic and daily life and, of course, have deeply affected measuring instruments and legal metrology. Industrial production is no longer limited to material devices, for their value is now widely based on "intelligence" and, therefore, their environment and interfaces can now be studied and their interactions adapted accordingly [17].

Information consumption has markedly increased, and will continue to do so. We are entering a post-industrial civilization in which most human production and economic values will stem from information provision and management. Metrology is the basic tool for societies in this new context [17].

Regarding legal metrology, the context in the year 2020 will be very different from that witnessed over the last few years [17]:

- "Simple" instruments will give way to network-integrated systems capable of performing complex operations, linking various types of measurements and controlling countless measuring results. Their elements will not be complete instruments, but mutually-interactive sensors, modules of instruments and data-processing systems;
- Instruments and systems able to carry out tasks now restricted to metrology or other specialized bodies: self-verification, self-calibration, maintenance assistance and behavior adaptation in real environmental or measurement conditions. These future instruments and systems could even be able to develop a relatively intelligent fraudulent operation and correct this operation in the event of detection by legal metrology authorities; and
- The scope of these measuring systems will be considerably extended to cover a wide range of measurements and quantities in almost all fields of human activity. Integrating measuring devices into global networks through frequent internet use will need legal metrology to cover the said networks.

The quick innovation cycles and the short times of adjustment call for new ways to prove conformity [12].

In this connection, legal metrology authorities will have to develop new ways to assure confidence in both measuring systems and measurements and replace traditional conformity assessment procedures with new ones. Legal metrology work will have to go global, failing which it will become ineffective. Pattern approval and initial verification will frequently be obsolete concepts. Confidence in the measuring systems and measurements will pave the way for a global approach to the whole life-cycle of instruments and measurements, from design to maintenance and use [17].

The role of the OIML will be to harmonize technical and metrological requirements, bring all these cooperations together under a Global Legal Metrology System and move toward a global international conformity assessment scheme based on mutual confidence among its Members [17].

The OIML's future plans are a true challenge for the establishment of infrastructures that facilitate the attainment of its objectives in the field of metrology. These challenges under the new circumstances are to:

- Accelerate its technical work considerably;
- Make OIML Recommendation requirements more functional so that they are not dependent on technology and can be quickly reviewed as necessary;
- Study the general infrastructure of conformity assessment procedures in order to adapt them to the new technologies, to the new measuring system structure, and to production and maintenance;
- Seriously consider the current redundancy of legal metrology institutes at international level and think about the need to reorganize and coordinate actions so that they can be more effective;
- Increase awareness of metrology and legal metrology; and
- Develop confidence and mutual recognition as a means toward an international conformity assessment system.

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OIML Certificate System:

Certificates registered 2006.02–2006.04

Up to date information (including B 3): 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 type 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 types certified.

The rules and conditions for the application, issuing and use of OIML Certificates are included in the 2003 edition of OIML B 3 *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 type 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 instrument category, certificates are numbered in the order of their issue (renumbered annually).

Pour chaque catégorie d'instrument, 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 type(s)
Type(s) certifié(s)

Applicant
Demandeur

Système de Certificats OIML:

Certificats enregistrés 2006.02–2006.04

Informations à jour (y compris le B 3): 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 type 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 types 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 B 3 *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 type 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

Diaphragm gas meters
Compteurs de gaz à parois déformables

R 31 (1995)

▶ Issuing Authority / *Autorité de délivrance*

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

R031/1995-NL1-2004.01 Rev. 1
Diaphragm gas meter
Ecometros S.L., C/Urgel, 240 2 °C, E-08036 Barcelona, Spain

R031/1995-NL1-2004.02 Rev. 1
Diaphragm gas meter
Destas Dijital Elektronik San. Tic A.S., Seyhly Mah Mimarsinan Cd. Hilak Sk. No. 33,
34906 Kurtkoy – Pendik – Istanbul, Turkey

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Water meters intended for the metering of cold potable water
Compteurs d'eau destinés au mesurage de l'eau potable froide

R 49 (2003)

▶ Issuing Authority / *Autorité de délivrance*

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

R049/2003-NL1-2006.01
Type: OPTIFLUX x300C(1); OPTIFLUX x000F(1) + IFC300
Krohne Altometer, Kerkeplaat 12, NL-3313 LC Dordrecht, The Netherlands

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

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

R 51 (1996)

▶ Issuing Authority / *Autorité de délivrance*

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

R051/1996-NL1-2005.02 Rev. 1
*Automatic catchweighing instrument - DACS-W-***-**, DACS-W-***-**N, BC-W-***-**, BC-W-***-**N, DACS-H-***-** and DACS-H-***-**N*
Ishida Co. Ltd., 959-1, Shimomagari, Kurita-Gun, Ritto-cho, 520-3026 Shiga, Japan

R051/1996-NL1-2006.01
Automatic catchweighing instrument. Type: LA46-pc
Hasma Nederland B.V, Lamalaan 8, NL-5691 GJ Son, The Netherlands

▶ Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R051/1996-DE1-2005.01
Automatic catchweighing instrument - Type: AB C
Mettler-Toledo Garvens GmbH, Kampstr. 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*

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

R060/2000-NL1-2005.22 Rev. 1
Compression load cell - Family of type: CA40X
Scaime S.A., Z.I. de Juvigny, B.P. 501,
F-74105 Annemasse Cedex, France

R060/2000-NL1-2006.01
Load cell - Type: AAA/AAL-130
Beijing Yuxiang Electronic Co. Ltd., N° Longtan Road,
Chongwen District, 100 061 Beijing, China

R060/2000-NL1-2006.02
Tension, S-type load cell. Type: CTL
Laumas S.r.l., via 1° Maggio n.6,
I-43030 Basilcanova Parma, Italy

R060/2000-NL1-2006.03
Shear beam load cell. Type: SQB
Keli Electric Manufacturing (Ningbo) Co. Ltd., 199
Changxing Road, Jiangbei District, Ningbo City, China

R060/2000-NL1-2006.04
Single point, bending beam load cell. Type: MT1241-…
Mettler-Toledo (Changzhou) Precision Instruments Ltd.,
5 HuaShanZhong Lu, ChangZhou, JiangSu, China

Issuing Authority / *Autorité de délivrance*

DANAK The Danish Accreditation and Metrology Fund, Denmark

R060/2000-DK1-2006.01
Beam bending, strain gauge load cell, Type: BB
ESIT Electronics, Mühürdar Cad. No. 91, Kadiköy,
TR-81300 Istanbul, Turkey

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*

International Metrology Cooperation Office, National Metrology Institute of Japan (NMIJ) National Institute of Advanced Industrial Science and Technology (AIST), Japan

R076/1992-JP1-2005.02
Type EK-i(K)
A&D Company Ltd., 3-23-14 Higashi-Ikebukuro,
Toshima-Ku, 170 Tokyo, Japan

R076/1992-JP1-2006.01
Type PW-630MA
Tanita Corporation (Brand names: Tanita, Rhewa,
Wunder), 14-2, 1-Chome, Maeno-cho, Itabashi-ku,
147-8630 Tokyo, Japan

R076/1992-JP1-2006.02
Type FG.../AD-6208...
A&D Company Ltd., 3-23-14 Higashi-Ikebukuro,
Toshima-Ku, 170 Tokyo, Japan

Issuing Authority / *Autorité de délivrance*

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

R076/1992-NL1-2004.11 Rev. 03
Non-automatic weighing instrument. Type: DS-700..
Shanghai Teraoka Electronic Co. Ltd., Ting Lin Industry
Development Zone, Jinshan District, Shanghai 201505,
China

R076/1992-NL1-2005.39 Rev. 1
Family of type: IND22x(BBA)-YYYZWWW
Mettler-Toledo (Changzhou) Precision Instruments Ltd.,
5 HuaShanZhong Lu, ChangZhou, JiangSu, China

R076/1992-NL1-2005.40
Type: SM-100..
Shanghai Teraoka Electronic Co. Ltd., Ting Lin Industry
Development Zone, Jinshan District, Shanghai 201505,
China

R076/1992-NL1-2006.01

Non-automatic weighing instrument - Type ML series

Motex Scales Co. Ltd., 222-105 Nae-Dong, Ojung-Gu, Bucheon-City, 421-160 Kyunggi-Do, Korea (R.)

R076/1992-NL1-2006.02

Non-automatic weighing instrument - Type K-Series

DIBAL S.A., c/ Astintze Kalea, 24, Poligono Industrial Neinver, E-48016 Derio (Bilbao-Vizcaya), Spain

R076/1992-NL1-2006.03

Non-automatic weighing instrument

Shanghai Teraoka Electronic Co. Ltd., Ting Lin Industry Development Zone, Jinshan District, Shanghai 201505, China

R076/1992-NL1-2006.04

Non-automatic weighing instrument. Family of type: CL5000 Series

CAS Corporation, CAS Building #440.1 Sungnae-Dong, Kangdong-KU, Seoul, Korea (R.)

R076/1992-NL1-2006.06

Non-automatic weighing instrument. Family of type: R300 series

Rinstrum Pty. Ltd, 41 Success Street, QLD 4110 Acacia Ridge, Australia

R076/1992-NL1-2006.07

Non-automatic weighing instrument. Family of type: R420 series

Rinstrum Pty. Ltd, 41 Success Street, QLD 4110 Acacia Ridge, Australia

R076/1992-NL1-2006.08

Non-automatic weighing instrument. Type: 8442 (Tiger P)

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

R076/1992-NL1-2006.09

Non-automatic weighing instrument. Type: HRS

Grupo Epelsa, S.L. or EXA, Ctra. Sta. Cruz de Calafell, 35 km. 9,400, Sant Boi de Llobregat, E-08830 Sant Boi de Llobregat - Barcelona, Spain

R076/1992-NL1-2006.10

Non-automatic weighing instrument. Family of type: GH series

A&D Instruments Ltd., Abingdon Science Park, Abingdon OX14 3YS, Oxford, United Kingdom

R076/1992-NL1-2006.11

Non-automatic weighing instrument. Type: Voyager and Explorer (Pro)

Ohaus Corporation, 19A Chapin Road, NJ 07058-9878 New Jersey, Pine Brook, New Jersey, United States

R076/1992-NL1-2006.12

Non-automatic weighing instrument. Family of type: DS-772...

Teraoka Weigh-System PTE Ltd., 4 Leng Kee Road, #06-01 SIS Building, 159088 Singapour, Singapore

R076/1992-NL1-2006.15

Non-automatic weighing instrument. Family of type: DS-980...

Shanghai Teraoka Electronic Co. Ltd., Ting Lin Industry Development Zone, Jinshan District, Shanghai 201505, China

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

R076/1992-DK1-2006.03

Non-automatic weighing instrument. Type JIK-6 & JIK-8

Jadever Scale Co. Ltd., No. 5, Wu-Chuan 2 RD., Wu-Ku Hsiang, Taipei Hsien, Chinese Taipei

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

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

R 117 (1995) + R 118 (1995)

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

R117/1995-NL1-2005.07

Fuel dispensers for Motor Vehicles, model "Global Vista Oil Mix"

Dresser Wayne Pignone, Via Roma 32, I-23018 Talamona (SO), Italy

R117/1995-NL1-2005.08

Type: DPX-A Light Oil Mix

Dresser Wayne Pignone, Via Roma 32, I-23018 Talamona (SO), Italy

Issuing Authority / *Autorité de délivrance*

Russian Research Institute for Metrological Service (VNIIMS)

R117/1995-RU1-2005.01 Rev. 1
Kaizen Fuel Dispensing Pump SPIRIT series/ROVER series/OPPORTUNITY series

Tokheim Kaizen Private Limited, A-174, TTC Industrial Area, MIDC, Village Khairane, 400709 Navi Mumbai, India

R117/1995-RU1-2005.02 Rev. 1
Kaizen Flow meters type KL-100

Tokheim Kaizen Private Limited, A-174, TTC Industrial Area, MIDC, Village Khairane, 400709 Navi Mumbai, India

R117/1995-RU1-2005.03 Rev. 1
Kaizen Flow meters type KL-200

Tokheim Kaizen Private Limited, A-174, TTC Industrial Area, MIDC, Village Khairane, 400709 Navi Mumbai, India

R117/1995-RU1-2006.01
Fuel Dispensers SOMO SME Series

Somo Petro Co., Ltd, SOMO Bldg, 984-1, Daechi-dong, Kangnam-Ku, 135-280, Seoul, Korea (R.)

OIML CERTIFICATE SYSTEM

List of OIML Issuing Authorities (by Country)

*The list of OIML Issuing Authorities will now be published in each issue of the OIML Bulletin. For more details, please refer to our web site: www.oiml.org/certificates. Entries in **bold red text** are new since the last issue of the Bulletin.*

AUSTRALIA

AU1 - National Measurement Institute	R 50	R 51	R 60	R 76	R 85	R 106
	R 107	R 117/118	R 126	R 129		

AUSTRIA

AT1 - Bundesamt für Eich- und Vermessungswesen	R 50	R 51	R 58	R 61	R 76	R 85
	R 88	R 97	R 98	R 102	R 104	R 106
	R 107	R 110	R 114	R 115	R 117/118	

BELGIUM

BE1 - Metrology Division	R 76	R 97	R 98

BRAZIL

BR1 - Instituto Nacional de Metrologia, Normalização e Qualidade Industrial	R 76

BULGARIA

BG1 - State Agency for Metrology and Technical Surveillance	R 76	R 98

CHINA

CN1 - State General Administration for Quality Supervision and Inspection and Quarantine	R 60	R 76	R 97	R 98

CZECH REPUBLIC

CZ1 - Czech Metrology Institute	R 76	R 117/118

DENMARK

DK1 - The Danish Accreditation and Metrology Fund	R 50	R 51	R 60	R 61	R 76	R 98
	R 105	R 106	R 107	R 117/118	R 129	
DK2 - FORCE Technology, FORCE-Dantest CERT	R 49					

FINLAND

FI1 - Inspecta Oy	R 50	R 51	R 60	R 61	R 76	R 85
	R 106	R 107	R 117/118			

FRANCE

FR1 - Bureau de la Métrologie — *All activities and responsibilities were transferred to FR2 in 2003*

FR2 - Laboratoire National de Métrologie et d'Essais	R 31	R 49	R 50	R 51	R 58
	R 60	R 61	R 76	R 85	R 88
	R 97	R 98	R 102	R 105	R 106
	R 107	R 110	R 114	R 115	R 117/118
	R 126	R 129			

GERMANY

DE1 - Physikalisch-Technische Bundesanstalt (PTB)	R 16	R 31	R 49	R 50	R 51
	R 58	R 60	R 61	R 76	R 88
	R 97	R 98	R 102	R 104	R 105
	R 106	R 107	R 110	R 114	R 115
	R 117/118	R 128	R 129	R 133	

HUNGARY

HU1 - Országos Mérésügyi Hivatal	R 76

JAPAN

JP1 - National Metrology Institute of Japan	R 60	R 76	R 115	R 117/118

KOREA (R.)

KR1 - Korean Agency for Technology and Standards	R 76

THE NETHERLANDS

NL1 - NMi Certin B.V.	R 31	R 49	R 50	R 51	R 60
	R 61	R 76	**R 81**	R 85	R 97
	R 105	R 106	R 107	R 117/118	R 126
	R 129	R 134			

NEW ZEALAND

NZ1 - Ministry of Consumer Affairs, Measurement and Product Safety Service	R 76

NORWAY

NO1 - Norwegian Metrology Service	R 50	R 51	R 61	R 76	R 105
	R 106	R 107	R 117/118	R 129	

POLAND

PL1 - Central Office of Measures	R 76	R 98	R 102

ROMANIA

RO1 - Romanian Bureau of Legal Metrology	R 97	R 98	R 110	R 114	R 115

RUSSIAN FEDERATION

RU1 - Russian Research Institute for Metrological Service	R 31	R 50	R 51	R 58	R 60
	R 61	R 76	R 85	R 88	R 93
	R 97	R 98	R 102	R 104	R 105
	R 106	R 107	R 110	R 112	R 113
	R 114	R 115	R 117/118	R 122	R 126
	R 128	R 129	R 133		

SLOVAKIA

SK1 - Slovak Legal Metrology (Banska Bystrica)	R 76	R 117/118

SLOVENIA

SI1 - Metrology Institute of the Republic of Slovenia	R 76

SPAIN

ES1 - Centro Español de Metrología	R 51	R 60	R 61	R 76	R 97
	R 98	R 126			

SWEDEN

SE1 - Swedish National Testing and Research Institute AB	R 50	R 51	R 60	R 61	R 76
	R 85	R 98	R 106	R 107	R 117/118

SWITZERLAND

CH1 - Swiss Federal Office of Metrology and Accreditation	R 16	R 31	R 50	R 51	R 60
	R 61	R 76	R 97	R 98	R 105
	R 106	R 107	R 117/118		

UNITED KINGDOM

GB1 - National Weights and Measures Laboratory	R 49	R 50	R 51	R 60	R 61
	R 76	R 85	R 98	R 105	R 106
	R 107	R 117/118	R 129	R 134	
GB2 - National Physical Laboratory	R 97				

UNITED STATES

US1 - NCWM, Inc.	R 60	R 76

TC 8/SC 1 MEETING (1/2)

Static volume and mass measurement

9–10 March 2006

Vienna, Austria

RICHARD GOBLIRSCH, BEV (Austria)

Following a merger of OIML TC 8/SC 1 *Static volume measurement* and OIML TC 8/SC 2 *Static mass measurement* the BEV Metrology Service (Austria) together with the German Co-secretariat Eichdirektion-Nord recently took over the responsibility for the Secretariat of the new TC 8/SC 1 *Static volume and mass measurement*.

A kick-off meeting was held in Vienna on 9–10 March 2006. Nine participants representing 6 P-Members (Austria, Belgium, Czech Republic, Germany, The Netherlands, USA) and the BIML attended the meeting. The 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
- R 125	(1998)	Measuring systems for the mass of liquids in tanks, Test report format
- *New proposal*		Measuring systems for the volume of liquids in fixed storage tanks
- *New proposal*		Hybrid tank measuring systems for determination of volume, density and mass of liquid hydrocarbons in vertical cylindrical fixed storage tanks.

The former two Working Groups (WG2 and WG3) have been confirmed and they should up-date the Recommendations R 71, R 80 and R 85, for all of which a second CD already exists.

The activities of the originally planned WG1 (Revision of R 95) were postponed.

Recommendation R 125 was within the scope of the former OIML TC 8/SC 2 and is now subject to a review. Voting on the proposed new Recommendation projects showed positive results: more than 50 % of P-Members voted in favor of each project. The discussion focussed on the problems concerning the propagation of the errors of the different input quantities (cross-sectional area, liquid level, temperature or density) and also the conversion volume ←→ mass.

After intensive discussions the participants decided to engage in particular in finishing the three “old” projects (OIML R 71, R 80 and R 85) and to postpone the work on the two “new” Recommendation projects until a Document could provide sufficient information on all the physical parameters involved in the use of hybrid measuring systems. This Document shall be a proposal of OIML TC 8/SC 1.

A further meeting to discuss the second Committee Drafts of R 71, R 80 and R 85 was already scheduled for 11–12 May 2006 in Hamburg (see opposite). ■

TC 8/SC 1 MEETING (2/2)

Static volume and mass measurement

11–12 May 2006

Hamburg, Germany

RICHARD GOBLIRSCH, BEV (Austria)

After the kick-off meeting in Vienna on 9–10 March 2006, a further meeting of TC 8/SC 1 was held in Hamburg from 11 to 12 May 2006. 17 participants representing 7 P-Members (Austria, China, Czech Republic, Germany, The Netherlands, Sweden, USA) and the O-Member country South Africa and the BIML attended the meeting.

Comments to the 2 CDs of the following Recommendations were discussed:

- R 71 *Fixed storage tanks*: A 3 CD will be prepared by WG2 after all the accepted comments have been included.
- R 80 *Road & rail tankers*: WG3 will produce a 3 CD of Part 1 "Technical and metrological requirements" after a WG meeting to be held on 7–8 September 2006 at the PTB in Braunschweig and it is deemed feasible to produce a DR during 2006. Development of Part 2 "Test methods" and Part 3 "Test report format" will be started at the September meeting.
- R 85 *Automatic level gauges for measuring the level of liquids in fixed storage tanks*: A 3 CD will be drafted by WG2 and circulated by the end of the Summer 2006. Voting by TC 8/SC 1 Members should be completed by November 2006 at the latest, with a DR still possible in 2006.

New projects

A new OIML Document *Parameters and techniques of tank gauging systems* will be prepared and is thought to be a helpful step towards a well-organized and efficient review of the scopes of the two proposed new Recommendation projects *Measuring systems for the volume of liquids in fixed storage tanks* and *Hybrid Tank Measuring Systems for determination of volume, density and mass of liquid hydrocarbons in vertical cylindrical fixed storage tanks*.

While the two proposals for new Recommendations have been postponed, the proposal to develop a Document will be submitted to the CIML for approval in 2007. Members of WG2 showed their willingness to continue the work with this project, despite a convenor not yet having been found.

The next meeting will take place at the BEV in Vienna on 8–9 March 2007 (to be confirmed). ■

RLMOs

COOMET: 15 years of collaboration

NIKOLAI ZHAGORA, COOMET President,
Director of the Belarussian State
Institute of Metrology

History of Euro-Asian cooperation between national metrological institutions

Foundation of COOMET

COOMET was established just before the discharge of the Council for Mutual Economic Assistance (CMEA). By that time, metrologists of the former USSR and other CMEA Member countries had gained a 20-year experience of successful multilateral cooperation in the framework of a Metrology Group of the Permanent Commission on Standardization of the CMEA (headed over various periods by B. Isaev, N. Rambidi, V. Kiparenko, L. Isaev, V. Pushkov, and V. Belotserkovsky). During this period a number of multilateral inter-governmental and inter-departmental agreements had been implemented in different fields of cooperation. Also, normative documents regulating cooperation projects and measurement standard/reference material infrastructures of the CMEA countries were worked out, along with the establishment of helpful contacts between CMEA metrologists. The effectiveness of this cooperation predetermined the need for its continuation in the face of new political and economical environments.

Following a suggestion by the Metrology Group leader V. Belotserkovsky, also supported by other members, coordination of the multilateral cooperation between metrologists of the former CMEA countries and the establishment of a corresponding regional organization was entrusted to the Metrology Group member Mr. Zbignev Referovski, Deputy Director of the Polish Committee on Standardization, Measures and Quality (PKNMiJ). This choice was dictated by Mr. Referovski's experience gained during his seven years as Assistant Director at the BIML. He was familiar with trends and the current state of cooperation in the field of metrology and had numerous contacts with representatives of the majority of international and regional metrological organizations. He also had the ability to freely communicate with people in various foreign languages such as Russian, English, French or German and was a devoted supporter of cooperation between metrologists of Eastern and Central Europe.

At the 37th meeting of the CMEA Metrology Group in Ulan-Bator, Mongolia (June 1990) held in parallel with a meeting of the NPO "Interetalonpribor" (see

Fig 1 Participants at the joint meeting of the CMEA Metrology Group and NPO "Interetalonpribor" in "Gold yurta" (Mongolia). In the center, a descendant of Chingiz Han (seated).

Fig. 1), preliminary suggestions were put forward on the reorganization of cooperation, assuming self-regulation of cooperation in the field of metrology (i.e. separately from cooperation in the field of standardization) at the level of national metrology organizations.

The 38th meeting of the CMEA Metrology Group took place in Konstanzin, Poland, in November 1990. By that time it was clear that the CMEA would soon discontinue its work and metrologists had the urgent task of facilitating the establishment of a community of metrologists. At this meeting a resolution about "the advisability of preserving cooperation in a transition period (until the establishment of a new organization) on the basis of multilateral agreements on metrology for the realization of projects and meetings of experts" was adopted.

Also, the general provisions of a draft Memorandum of Understanding (MoU) of state metrology organizations of the counties of Eastern and Central Europe were agreed on and the timing for its final publication and approval was set. The MoU on European cooperation on measurement standards (EUROMET was established in September 1987) was taken as a basis for this document.

A practical meeting focusing on discussions and approval of the MoU was held in April 1991 in Warsaw. The accepted addition of the MoU was then circulated to all members of the CMEA Metrology Group for consideration and voluntary approval.

Several abbreviated names for the new regional cooperation were proposed: UNIMET, INTERMETR, etc. However, the name proposed by Mr. Referovski was agreed on: COOMET (short for "cooperation in metrology"). As distinct from EUROMET (a regional metrology organization, or RMO) which united metrology organizations only from Western Europe, COOMET (like the CMEA) envisaged membership for countries of different regions of the world. It was agreed that restriction to one single region might exclude organizations willing to cooperate.

Mr. Referovski and his colleagues, on behalf of Poland, contributed a lot to the establishment of COOMET and the successful completion of the routine work, which included both the development of the relevant documents and the organization of meetings and consultations with the authorities of the BIPM, BIML, EUROMET and national metrology institutes.

The contribution of Russian metrologists in the establishment of COOMET was also substantial. During recent meetings of the CMEA Metrology Group (led by Mr. V. Belotserkovsky with Mr. B. Gorshkov as secretary), some good ideas were put forward by the former USSR delegation. These ideas concerned the principle of the new cooperation and structure of the regional organization to be established. Representatives of other countries played an active role in the COOMET foundation: Bulgaria (V. Gavrailov, E. Alexandrov), Hungary (D. Beledi, A. Szilvássy), Germany (M. Kochsiek, R. Brust), Romania (A. Millea), and Czechoslovakia (M. Cibak, J. Orlovsky).

A ceremony to mark the signing of the COOMET MoU and the official declaration of the establishment of COOMET was held on 12 June 1991 in Warsaw (in PCSMK). The MoU was signed by representatives of the state metrology organizations of five countries: Bulgaria, Poland, Romania, USSR and Czechoslovakia. This was a real achievement, because two weeks later (28 June) the official removal from office of the CMEA was announced at its 46th session in Budapest. Thus any delay in the establishment of the new metrology organization would hinder multilateral cooperation, which was based on agreements concluded in the framework of the CMEA.

Unfortunately, not all the signatories of the COOMET MoU became full members. For instance, the representative of Hungary attended two initial COOMET meetings as an observer and then Hungary joined EUROMET according to a decision by its government.

After the political "divorce" of Slovakia and the Czech Republic only the Slovak Metrology Institute (SMU) (on behalf of Slovakia) remained a member of COOMET.

Development of COOMET

The first years of COOMET cooperation witnessed rapid growth and a number of proposed projects. This fact was maybe due to a sense of euphoria in the field of metrology caused by the unleashed independence of the countries of the former USSR. By the end of 1992 more than 111 projects had been registered!

In November 1991 Germany and Cuba became COOMET Members, in 1992 Belarus and Ukraine, in 1993 Lithuania, in 1997 Moldavia, and in 1998 Kazakhstan.

In May 2000, for the purpose of facilitating granting COOMET Membership to European and Asian metrology organizations, COOMET changed its name to "Euro-Asian Cooperation of National Metrological Institutions". Unfortunately, in the meantime (June 2000) Poland left COOMET for EUROMET which was due to Poland joining the EC. Despite this, Poland continued its work on some COOMET projects and COOMET was sad to see this country leave. COOMET went on to welcome new members: in 2000 Kyrgyzstan, in 2002 the DPR of Korea, and in 2004 Uzbekistan.

Naturally, the first elected President of COOMET was Mr. Referovski, who presided two consecutive

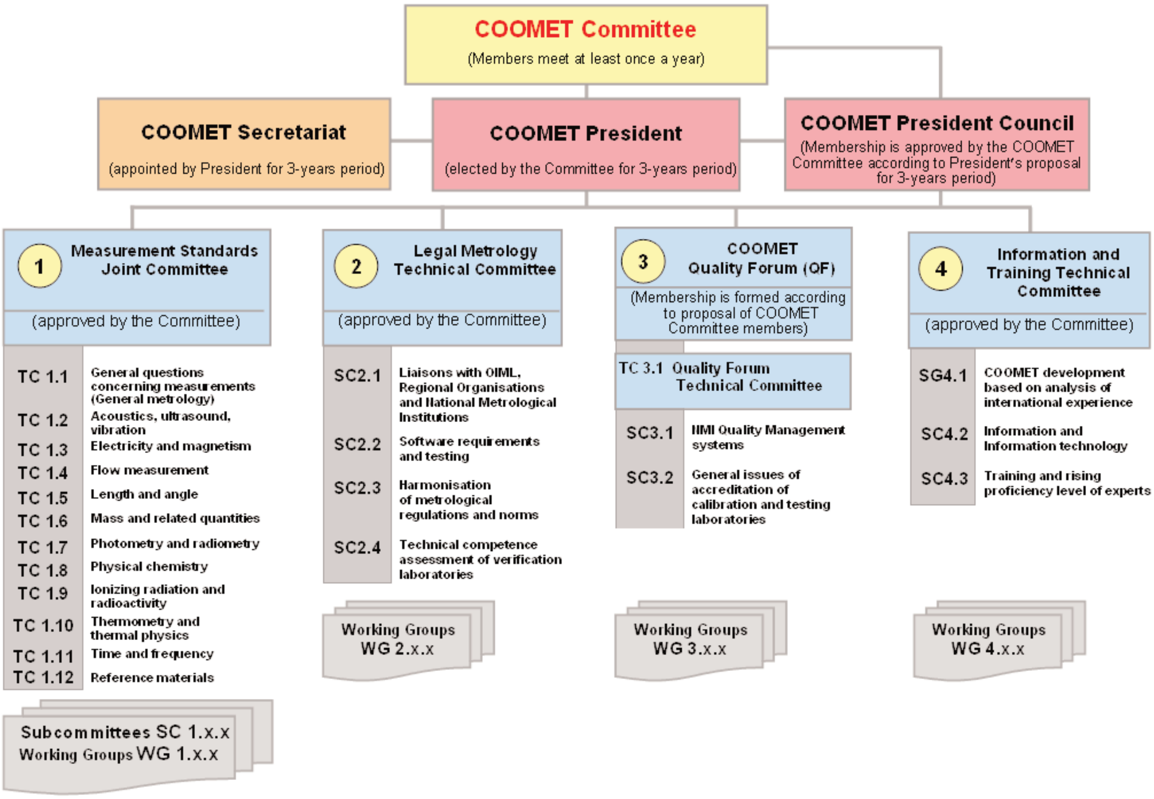

Fig. 2 New organizational structure of COOMET

meetings of the COOMET Committee in Warsaw. At this first stage of COOMET's formation Mr. Referovski did much to promote COOMET activities and to secure its position in the metrology community. On his retirement, the COOMET Committee acknowledged his contribution and granted him the title of Honorable COOMET President.

In 1994 the COOMET management (President Z. Referovski, Secretary M. Klarner-Sniadowska) moved from Poland to Slovakia (R. Spurny, E. Kromkova), in 1998 to Russia (V. Belotserkovsky, B. Gorshkov), and in 2001 to Belarus (N. Zhagora, L. Astafijeva). Each presiding country successfully contributed to the improvement of COOMET activities and its regional status.

COOMET also considerably benefited from the participation of PTB specialists: Vice-President M. Kochsiek, who was the German representative in COOMET until 1998, H-D Velfe, H. Apel, R. Hahnewald, and A. Odin. At this time the PTB had the most advanced measuring facilities in Europe and supported the development of COOMET on the basis of bi- and multilateral agreements, thus contributing to finding solutions to numerous metrology issues.

The initial development stage of COOMET overlapped with the period of transformation and revision of national legislation in the field of metrology which was provoked by the conception of free trade. Major efforts concentrated on defining the scope of the legal metrology area and new principles of market surveillance. These issues are still vital for a number of COOMET Member countries and have been discussed in the Legal Metrology Technical Committee, led by experts from Germany.

Taking into consideration the active participation of the PTB in several international (notably the Metre Convention and the OIML) and regional (EUROMET, WELMEC) metrology organizations its contribution in highlighting and solving legal metrology issues within COOMET has been inestimable.

Cooperation it the field of legal metrology under the supervision of the PTB started from a series of workshops under the title "Infrastructures of metrology in industrial countries - Current situation and perspectives". Such seminars, organized with the assistance of the German Academy of Metrology (DAM), were held in Bulgaria, Poland, Belarus, Russia (in three cities) and the Ukraine from 1992 to 1994.

Another way COOMET metrologists attracted attention to the urgent issues of legal metrology was through international conferences and workshops. The participation of COOMET representatives in these events was largely sponsored by the PTB.

Beside the persons mentioned above, the following specialists made considerable contributions to COOMET's development: A. Todorova (Bulgaria), V. Koreshkov, N. Lyakhova, M. Shabanov, V. Pozdeeva, T. Kolomietz, (Belarus), O. Staugaitis, V. Gegevichus, I. Lazdauskayte (Lithuania), E. Hanganu, A. Tarlazhanu (Moldova), L. Isaev, V. Krutikov, V. Lakhov, A. Astashenkov, S. Kononogov, V. Alexandrov, A. Pokhodun, L. Konopelko, A. Chunovkina, V. Kuznetsov, N. Muravskaya, V. Bugaev, Y. Bregadze, V. Tatarenkov, D. Vasiliev, V. Yaryna, S. Korostin, V. Leonov (Russia), D. Podgorsky, P. Kneppo, M. Bily, S. Duris, S. Musil (Slovakia), I. Alekseev, V. Ogolyuk, G. Sidorenko, B. Markov, Y. Pavlenko, L. Nazarenko, V. Solovjov, V. Bolshakov, P. Neyezhmakov (Ukraine).

The beginning of the most active period of COOMET cooperation dates back to 1999 when a resolution was adopted at the 9th COOMET Committee meeting (Moscow) regarding measures for improving the effectiveness of COOMET activities; this resolution was transformed into the COOMET Development program. The realization of Development programs in 2001-2002, 2003-2004 and 2005-2007 ensured a noticeable increase in the effectiveness of cooperation.

In 2000 an article in the COOMET MoU laid down provisions for the institution of the COOMET Vice-Presidents and the Presidential Council. This structure includes representatives of Belarus, Germany, Russia, Slovakia, and Ukraine and forms an active group of associates who manage COOMET activities especially in the periods between COOMET Committee meetings.

Big changes followed the adoption and implementation of a new organizational structure of COOMET (see Fig. 2), which allowed separate structural units to be established in each specific field of cooperation and attract more specialized experts in the corresponding projects.

As can be seen from new organizational structure of COOMET, the main subject fields are represented by four structural units of COOMET:

1- Joint Committee on measurement standards (with 12 Subcommittees);
2- Technical Committee on Legal Metrology (TC 2);
3- COOMET Quality Forum;
4- Technical Committee on Information and Training (TC 4).

Each unit is headed by one country as follows: 1 Russia, 2 Germany, 3 Slovakia, 4 Belarus. These countries, including the Ukraine (which is responsible for interaction with the Euro-Asian Council for standardization, metrology and certification of the CIS) are the most active members of COOMET. Judging from the number of TCs led by Members (TC/SC Secretariats: Belarus 3, Germany 1, Russia 7, Slovakia 2, Ukraine 3) Lithuania should also be counted among the active Members since this country has held the Secretariat for TC 1.6 on "Mass and related quantities" for a number of years.

An important stage in the development of COOMET dates back to the beginning of the work regarding the establishment of a Global Measurement System, more precisely the signing of an Agreement on the mutual recognition of measurement standards and calibration/measurement certificates (CIPM MRA) by some National Metrology Institutes (NMIs) - COOMET Members - in October 1999.

Participation of COOMET in the implementation of the MRA gave direction to COOMET activities and set up practical objectives aimed at the creation of an international market of metrological services, and the following:

- Planning and arrangement of key and additional regional comparisons;
- Regional and interregional review of the calibration and measurement capabilities (hereinafter referred to as CMCs) of COOMET Members and metrology institutes of other RMOs; and
- Assessment of the effectiveness of the quality management systems of COOMET NMIs (MRA participants).

The majority of the structural and working units of COOMET participate in the implementation of the CIPM MRA. First of all, there is the Joint Committee on Measurement Standards and its subcommittees, the Quality Forum and several other units, e.g. TC 4.

It is worth mentioning the key role that the Slovak Metrology Institute (SMU) plays in Quality Forum activities relating to the realization of the MRA. An important point of the MRA realization is the active participation of regional metrology organizations in the Joint Committee of Regional Metrology Organizations and the BIPM (JCRB). COOMET fulfills this condition, as do other RMOs such as EUROMET, APMP, SADCMET, and SIM.

COOMET today

Today, COOMET is an internationally recognized regional metrology organization with wide-ranging international contacts and having the necessary organizational, juridical and methodological basis for developing and improving cooperation. The COOMET Development program for 2005–2007 is being realized accordingly.

At the 15th COOMET Committee meeting (September 2005, Vilnius, Lithuania - see Fig. 3) a conception of cooperation and activities was adopted, proving the maturity of this RMO. Conception is a versatile tool for planning and analyzing future ways of development which helps to set objectives at least for the mid-term period with respect to the current and predicted trends in the world economy and social sphere, as well as for summarizing the methodology and development of structural units of COOMET.

Today we can proudly note the results of COOMET cooperation:

- COOMET Members are the metrological organizations of 14 countries: Belarus, Bulgaria, Cuba, Germany, Kazakhstan, DPR of Korea, Kyrgyzstan, Lithuania, Moldavia, Romania, Russia, Slovakia, Ukraine and Uzbekistan;
- The COOMET organizational structure includes 30 permanent steering and working units;
- Over the years of cooperation, more than 350 projects have been suggested. Annually, about 30 new projects are proposed and there are almost the same number of completed projects. At present more than 60 projects are ongoing;
- Cooperation is implemented by more than 200 experts in COOMET Member countries who are involved in the activities of the COOMET Committee, TCs, SCs, etc.
- Additional resources are annually estimated as approximately 300 experts engaged in COOMET projects.

More than 50 percent of the overall number of COOMET projects are projects concerning measurement standards and the realization of the MRA.

COOMET Member countries actively participate in completing the international database on CMCs of NMIs. The portion of CMCs submitted by COOMET NMIs and published in the database amounts to over 15 % of the total number of entries published. CMCs are submitted to the database through COOMET by Belarus, Cuba, Russia and Ukraine. In January 2006 the MRA was signed by Kazakhstan, and Moldova is currently in the process of signing. Bulgaria, Germany, Lithuania, Romania and Slovakia submit their CMCs to the BIPM through EUROMET.

For the purpose of the international recognition of measurement standards and CMCs, the accuracy of standards has to be supported by the results of international comparisons. Thus, at the 15th COOMET Committee meeting a COOMET Program of comparisons was adopted together with its rules of implementation, and provision was made for comparisons between COOMET Member countries including participation of NMIs from the United Kingdom, Denmark, Israel, Poland, Latvia and Turkey.

Besides the results of comparisons an indispensable condition for recognition mentioned is the establish-

Fig. 3 Participants at the 15th COOMET Committee meeting (Vilnius, September 2005)

ment and implementation of Quality Systems (QS) in NMIs. Assessment of the effectiveness of QS implemented is carried out by a Quality Forum in two stages:

1 Consideration of the corresponding documentation and presentation of QS at the meeting of the Quality Forum; and
2 Performance of external audits (peer review) of QS of NMIs by a group of experts from different countries appointed by the Quality Forum.

After completion of the first stage, the Quality Systems of the following COOMET Member countries were accepted: Cuba, Russia, Belarus, Ukraine (signatories to the MRA) and Moldova. External audits in 2005 were performed on VNIIM, VNIIOFI, VNIIFTRI, VNIIMS (Russia), BelGIM (Belarus), NSC "Institute of Metrology" and Ukrmetrteststandart (Ukraine). A schedule of external audits of other NMIs has already been drawn up.

A template of a calibration and measurement certificate has been finalized and takes into consideration BIPM recommendations; it is recommended for use in COOMET Member countries in 2006.

In the field of legal metrology a program of cooperation is being implemented and many COOMET Member countries are showing an interest in it, especially under conditions of changing legislation. Among COOMET Publications published in this field of cooperation, the following should be mentioned:

- Layout, presentation, drawing up and contents of measuring instrument type specification for a national register of measuring instruments; and
- Software for measuring instruments: General technical specifications.

A project is under development regarding the requirements of the system of proving conformity to approved type (project 297/RU/04) and a project regarding the arrangement of initial verification with regard to the quality systems of manufacturers (project 298/RU/04).

Today COOMET is focusing on activities in the field of information and training (TC 4). Activities of this TC to a great extent concern the realization of the MRA. For instance, VNIIFTRI is developing a database for storing and searching CMCs of COOMET Members. TC 4 has prepared a review entitled "National educational systems in the field of metrology in COOMET Member countries".

The TC 4 work program for 2005-2007 envisages the publication of the COOMET Bulletin, the COOMET Directory and an informational leaflet about COOMET. TC 4 also plans an exchange of training programs in the field of metrology and training for metrologists in COOMET Member countries. TC 4 activities in 2005 included the following:

- BIPM-JCRB-COOMET Workshop "The role of the CIPM MRA in international cooperation in the field of metrology and in supporting trade and economic interrelations" (11 May 2005, Minsk, Belarus);
- An international Conference on metrology and measurement techniques, MKMIT - 2005 in the framework of an international forum "Applied radio-electronics. Current state and perspectives" (20–23 September 2005, Kharkov, Ukraine);
- An international Workshop "Urgent issues of control of prepackages" (27–30 September 2005, BelGIM, Minsk, Belarus) with the assistance of colleagues form Germany.

Among multilateral agreements on training of metrologists of COOMET Member countries, the following should be especially mentioned (both events were hosted by the PTB):

- Hardness measurements (31 October–11 November 2005); and
- Pressure measurements (7–11 November 2005).

An important contribution of TC 4 to the improvement of COOMET cooperation is the development and maintenance of the COOMET web site (www.coomet.org). At present the site contains COOMET working documents and can accommodate separate pages for each structural unit of COOMET. Further improvement of the site will include a separate page for information regarding the realization of the CIPM MRA.

At the last COOMET Committee meeting a badge "Honorable metrologist of COOMET" and a provision for its application were finally approved and will be granted to the most active participants.

Thus COOMET celebrates its 15th anniversary as a solid, internationally recognized regional metrology organization which has already made noticeable achievements and which is steadily implementing its development program. The outcomes of COOMET cooperation facilitate the management of metrology issues that have an impact on the economy at national level.

The robustness and effectiveness of COOMET depends to a great extent on the high degree of professionalism of its administration, especially the chair country. The present chair country, Belarus (and its NMI BelGIM which holds the Secretariat), is now effectively and efficiently managing activities for a second term.

In 2006 and thereafter, COOMET will engage in a number of challenges ensuring its further improvement and broadening of cooperation borders. COOMET Members believe in further growth of the organization and its success in regional and world metrology. ■

41st CIML Meeting, Cape Town, 2006:

Draft Agenda (Version 1)

Opening address
Roll-call - Quorum
Approval of the agenda

1 Approval of the minutes of the 40th CIML Meeting

2 Member States and Corresponding Members
2.1 Situation of certain Members

3 Financial matters
3.1 Adoption of the Auditor's report for 2005
3.2 Assets and liabilities as at 01/01/2005 and at 01/01/2006
3.3 Analytical accounts, estimates for 2006
3.4 Progress on the Pension Scheme

4 Presidential Council activities
4.1 Report on Presidential Council activities
4.2 Long Term Strategy and Action Plan

5 Developing Country activities
5.1 Report on PWGDC activities
5.2 Report on JCDCMAS activities

6 Liaisons
6.1 Presentation by the Bureau on liaison activities
6.2 Updates by Liaison Organizations
6.3 Updates by RLMOs

7 BIML activities
7.1 Organization of the Bureau
7.2 Communication, web site
7.3 Report on BIML activities for 2005-2006

8 Technical activities
8.1 Approval of International Recommendations and Documents
8.2 Examination of the situation of certain TCs/SCs
8.3 MAA
8.4 Progress on the revision of the *Directives*

9 Human resource matters
9.1 Election of a CIML Vice-President
9.2 Appointment of a new Assistant Director
9.3 Dispute related to the dismissal of a BIML Secretary

10 Future meetings
10.1 42nd CIML Meeting (2007)
10.2 13th Conference and 43rd CIML Meeting (2008)

11 Awards

12 Other matters

OIML

SABS

41st CIML Meeting

and Associated Events

Cape Town
South Africa

11–20 October 2006

For registration, accommodation, airport shuttle service, visas, tours, etc. please use the online facilities available at:

www.oiml.org/capetown

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Fax: +33 1 4282 1727

Cape Town 2006

The 41st CIML Meeting will be hosted by the South African Bureau of Standards (SABS) in the conference facilities of the five-star Arabella Sheraton Grand Hotel, Cape Town (South Africa) from 18 to 20 October 2006.

There will also be meetings of:

- OIML TC 6,
- SADCMEL,
- WG on Conformity,
- PWGDC, and
- a Seminar on Packaging, organized by SABS.

See detailed Schedule for details.

Practical information: Summary

Cape Town - Introduction

Cape Town (pop. ca. 1.5 millions} is one of the most important ports in the southern hemisphere. It is the oldest city in South Africa, and is situated on the Southern tip of the African Continent in beautiful scenery between ocean and mountains.

Accommodation

The Organizing Committee is handling accommodation bookings in the four recommended hotels. Delegates are invited to use the form available on the Cape Town web site to make their reservations, but should bear in mind that the deadline for reservations is 31 August 2006. Rooms cannot be guaranteed after this date.

Passports and visas

All non South African Nationals require a valid passport (containing at least three blank pages) and possibly also a visa. Visa applications should be made prior to departure in your local South African Embassy, Consulate or Diplomatic Mission and inquiries should be made well in advance to ensure that enough time is allowed.

If necessary, SABS can supply you with an attestation to facilitate obtaining a visa; please contact them for such requests.

Airport shuttle service to the Hotel

There is a bus shuttle service from Cape Town International Airport to the hotels; the fare is about ZAR 120 (single journey) per passenger. Please book via the web site.

Climate

The weather in Cape Town in October is generally cool and pleasant. The average daily temperature is 22 °C and the minimum is 11 °C. There is the chance of occasional rain showers. Light clothing, with something warm to wear in the evenings, is recommended.

Languages

The 41st CIML Meeting will be held in English, and simultaneous translation will be provided into French.

Full information:
www.oiml.org/capetown

If you are unable to use the web site, please contact the BIML and paper copies will be sent to you

The OIML is pleased to welcome the following new

CIML Members

- **Croatia:**
  Mr. Mirko Vukovič
- **Kazakhstan:**
  Mr. Gabit Mukhambetov
- **Saudi Arabia:**
  Mr. Nabil Bin Amin Molla

OIML Meetings

11–20 October 2006 - Sheraton Hotel, Cape Town, South Africa

- 41st CIML Meeting
- Meeting of OIML TC 6 "Prepackaged goods"
- Working Group on Conformity to Type
- Seminar on Pre-packaging
- Permanent Working Group on Developing Countries
- Presidential Council meeting

8–9 March 2007 - Vienna, Austria (To be confirmed)

TC 8/SC 1 Static volume and mass measurement

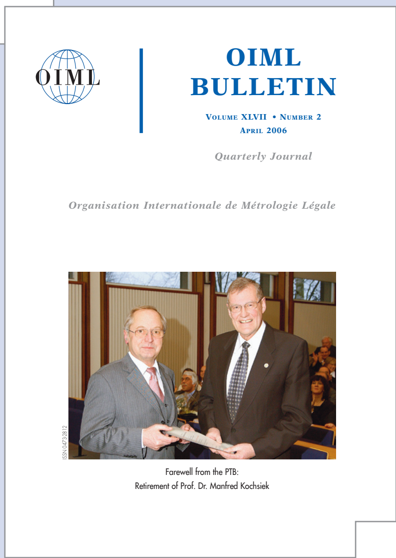
Committee Drafts

Received by the BIML, 2006.03 – 2006.05

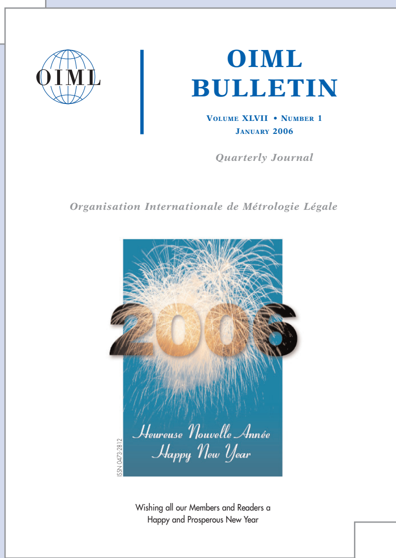
Revision R 126: Breath alcohol analyzers	E	2 CD	TC 17/SC 7	FR
Protein measuring instruments for cereal grain and oil seeds	E	1 CD	TC 17/SC 8	AU
Impression and applanation tonometers	E	2 CD	TC 18	DE
Pressure transducers with unified (4 - 20) mA or (10 - 50) mA output signal	E	4 CD	TC 10/SC 1	CZ
Revision R 46: Electricity meters	E	3 CD	TC 12	SE
Revision D 5: Principles for the establishment of hierarchy schemes for measuring instruments	E	2 CD	TC 4	SK
Guide for the application of ISO/IEC 17025 to assessment of Testing Laboratories involved in legal metrology testing	E	1 CD	TC 3/SC 5	US+BIML
Revision R 21: Taximeter systems	E	4 CD	TC 7/SC 4	UK

Call for papers

OIML Members
RLMOs
Liaison Institutions
Manufacturers' Associations
Consumers' & Users' Groups, etc.



- Technical articles on legal metrology related subjects
- Features on metrology in your country
- Accounts of Seminars, Meetings, Conferences
- Announcements of forthcoming events, etc.



The **OIML Bulletin** is a forum for the publication of technical papers and diverse articles addressing metrological advances in trade, health, the environment and safety - fields in which the credibility of measurement remains a challenging priority. The Editors of the Bulletin encourage the submission of articles covering topics such as national, regional and international activities in legal metrology and related fields, evaluation procedures, accreditation and certification, and measuring techniques and instrumentation. Authors are requested to submit:

- a titled, typed manuscript in Word or WordPerfect either on disk or (preferably) by e-mail;
- the paper originals of any relevant photos, illustrations, diagrams, etc.;
- a photograph of the author(s) suitable for publication together with full contact details: name, position, institution, address, telephone, fax and e-mail.

Note: Electronic images should be minimum 150 dpi, preferably 300 dpi.

Papers selected for publication will be remunerated at the rate of 23 € per printed page, provided that they have not already been published in other journals. The Editors reserve the right to edit contributions for style, space and linguistic reasons and author approval is always obtained prior to publication. The Editors decline responsibility for any claims made in articles, which are the sole responsibility of the authors concerned. Please send submissions to:

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