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New method and instrument for heat metering and billing

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OIML SECRETARIAT

BUREAU INTERNATIONAL DE MÉTROLOGIE LÉGALE (BIML)

11 RUE TURGOT – 75009 PARIS – FRANCE

TEL: 33 (0)1 4878 1282

FAX: 33 (0)1 4282 1727

INTERNET: www.oiml.org or www.oiml.int

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Editorial

JEAN-FRANÇOIS MAGAÑA
BIML Director

Legal metrology and road safety

This year on 7 April the World Health Organization (WHO) organized World Health Day on the theme of road safety and the event was launched in Paris by the French President Jacques Chirac. The WHO web site contains a number of reports, speeches, videos, etc., which show the importance of road safety, not only in industrialized countries which have a high density of vehicles, but also in Developing Countries, which also suffer from too many deaths and injuries caused by road accidents. These pages may be consulted at www.who.int/world-health-day/2004/en/

Legal metrology addresses a large number of issues related to road safety, and strongly supports policies to decrease road casualties. Measuring instruments that can be subject to legal metrology activities cover:

- the behavior of drivers (speed, alcohol, distance between vehicles, tachographs, etc.), and
- the safety of cars themselves (brake testing, tyre pressure, speed limiters, shock absorbers, headlights, etc.).

The extensive use of such measurements has been proved successful in significantly decreasing the number and gravity of road casualties in many countries. Road safety is a field in which legal metrology can show its benefits to society and this should be an occasion to raise the awareness of Governments concerning our activity. ■

La métrologie légale et la sécurité routière

L'Organisation Mondiale de la Santé a placé la Journée Mondiale de la Santé, le 7 avril 2004, sous le thème de la Sécurité Routière. Cet événement a été lancé à Paris, par le Président Français M. Jacques Chirac. Le site internet de l'OMS présente un certain nombre de rapports, de discours, de vidéos, etc., qui montrent l'importance de la sécurité routière, non seulement dans les pays industrialisés qui possèdent une densité de véhicules importante, mais aussi dans les pays en développement, qui souffrent aussi d'un trop grand nombre de décès et de blessés causés par les accidents de la route. Ces pages web peuvent être consultées à l'adresse suivante: www.who.int/world-health-day/2004/fr/

La métrologie légale traite d'un grand nombre de sujets ayant trait à la sécurité routière, et apporte un fort soutien aux politiques destinées à diminuer les accidents de la route. Les instruments de mesure qui peuvent être soumis aux contrôles de métrologie légale couvrent:

- le comportement des conducteurs (vitesse, alcool au volant, chronotachygraphes, etc.), et
- la sécurité des véhicules (efficacité de freinage, pression des pneus, limiteurs de vitesse, état des amortisseurs, projecteurs, etc.).

L'utilisation de tels mesurages a démontré qu'elle faisait fortement diminuer les taux et la gravité des accidents de la route dans de nombreux pays. La sécurité routière est un domaine dans lequel la métrologie légale peut montrer son utilité pour la société et ceci devrait être une occasion pour sensibiliser les Gouvernements à notre activité. ■

HEAT METERING

New method and instrument for heat metering and billing

PAUL DÂRVARIU
Romanian Bureau of Legal Metrology (BRML)

This paper contains some results of studies carried out by the author over five years, in the field of heat metering and billing. The method and instrument used for consumption-based heat energy billing are described in some national and international applications for patent.

Introduction

The energetic efficiency of a heating system much depends on the quality of the building insulation. The relative position of the rooms within the building is very important, too. The example in Fig. 1 shows that in a block of apartments significant differences could appear between energy consumptions, even if a similar thermal comfort level is assumed [1,2,7,12,13].

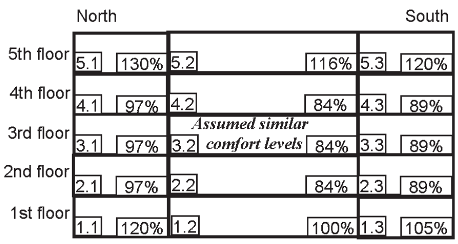


Fig. 1 Heat consumption per square meter, depending on the apartment exposition

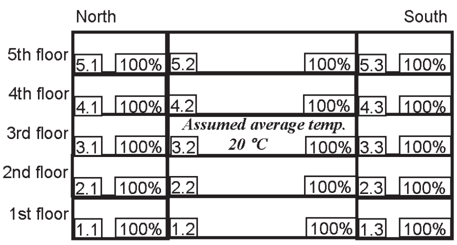


Fig. 2 Heat energy billing based on the floor area (Method A)

Until 1989 in Romania, as in other Eastern European countries, the owner of an apartment himself could seldom choose the location of his apartment: usually the authorities imposed this choice. On the other hand, the quality of the thermal insulation of a given apartment (roof, ceiling, basement, external walls, windows, etc.) concerns the building as a whole, not only individual households. An individual consumer does not have any influence over heat losses that occur simply because an apartment has more outer wall area than another, or because it is located on the northern side of the building rather than on the southern side [12]. That is why it is always difficult to explain to a Romanian living in one apartment that he should pay much more for heat than his neighbor living in a better-protected apartment, although they have similar comfort levels.

Three methods for heat billing

The most common method for heat billing in Romania is based on the floor area (Method A). Romanian legislation applies a compensation allowance for exposition (see Fig. 2) where for all the apartments in a block a similar thermal comfort level (20 °C) is assumed and the cost of heating per square meter is the same, irrespective of thermal insulation and orientation [3,4].

In many Western European countries (such as Germany, Switzerland or Denmark) heat energy billing is based on the use of heat cost allocators (HCAs). In addition to metering the heat consumption of the entire building, the heat emission of each radiator is "measured" with an HCA (see Fig. 3).

$$P = P_N \frac{(DT_0)}{(DT_{0N})^n} = \frac{P_N}{(DT_{0N})^n}(DT_0)^n = C_H (DT_0)^n$$

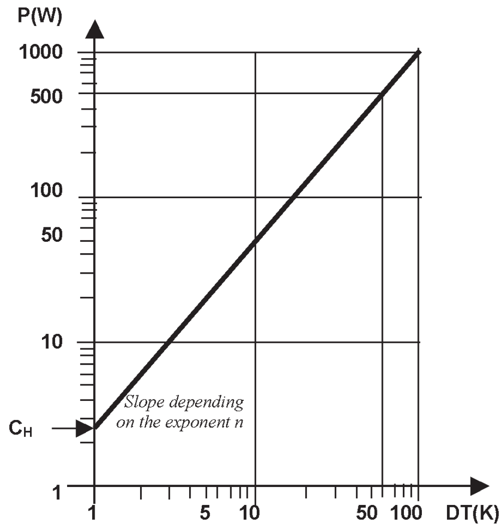


Fig. 3 Basic principle of a classical heat cost allocator (HCA)

An HCA (either based on the measurement of evaporation or electronic), is attached to each radiator. The HCA does not measure the heat content of the water (as does a heat meter according to OIML R 75 and EN 1434), but provides a value which is in proportion to the amount of energy emitted since the factors C_H and n from the equation in Fig. 3 depend on the size, shape and material of each individual radiator [5].

Billing based on actual values of consumption (Method B) is shown in Fig. 4a. For a particular period and for each apartment, these consumptions give average temperatures from 11.8 °C to 22.0 °C. It is assumed that these sensitive differences between levels of consumption and comfort are caused not only by the energetic behavior of the inhabitants but also by the specific location of each room in the building. Unfortunately, by using contemporary methods it is difficult to ascertain the specific contributions of each factor. However, by correcting the consumption indices given in Fig. 4a with the compensation factors provided as examples in Fig. 1, the indices given in Fig. 4b are obtained. These last indices, which fully describe the inhabitants' behavior, are considered in several countries (such as Denmark, Switzerland and Poland) as rational data available for heat billing (Method C). This method is based on the principle of *equal costs for an equal floor area heated with an equal energetic behavior* [1,12].

Practically, Method C allocates heat cost by performing accurate metering with classical HCAs and by carrying out a very specialized and sophisticated analysis, in order to determine the correction factors depending on the room's situation in the building [1,5,6,8]. In Switzerland, the use of correction factors is very complex. Not only is the location impact on the bill taken into account, but also any additional heat source such as pipes passing through the apartment [1]. According to many experts, the Swiss regulations have led to a billing system which is so complex that it defeats its purpose of providing consumers with information on their energy use and incentives to save energy [12].

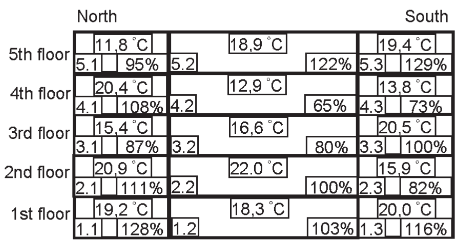


Fig. 4a Heat billing based on metering: Billing based on actual values of consumption (Method B)

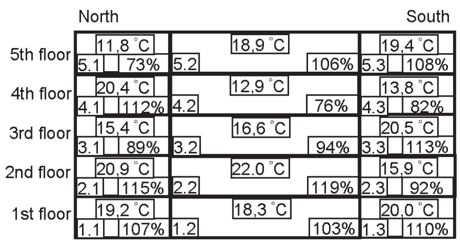


Fig. 4b Heat billing based on metering: Consumptions compensated with exposition factors (Method C)

A comparison between the three billing methods is shown in the chart in Fig. 5. The example of apartments 2.2 and 5.1 is quite relevant concerning the sensitive differences between Methods B and C (the allocation indices are completely inverted). That is why in many countries only combinations between Method A and Methods B or C are used. The total cost (billing cost included) of the heat consumption (measured with a building level heat meter) is allocated to the individual apartments partially according to the floor area and partially based on the readings of the HCAs [1,12].

What is the "thermal comfort level"?

The main disadvantage of Method C is that even if it is technically and socially quite correct, it is based on some unreliable and subjective compensation factors applied to the quite accurately measured heat emission of a radiator [1,5,6,7]. Using compensation factors to arrive at fair billing is justified only if large discrepancies in heat consumption are found between similar dwellings in different locations, excluding behavioral differences [12].

Our studies have concluded that we can imagine an objective, efficient and simple method (the TCL Method), by using only information about the indoor temperature (T_{Room}) and external temperature (T_e).

We can imagine an equation (1), which gives I_{TCL}, a quantity called the "index of thermal comfort level" for a particular room along a particular period:

$$I_{TCL} = \frac{\int (T_{Room} - T_e)\, d\tau}{\int (20 - T_e)\, d\tau}\ 100 \qquad (1)$$

According to Equation (1), the *index of the thermal comfort level* in a heating period is the ratio in percent between the energy consumed for assuring a particular temperature *(T_{Room})* in a room and the energy that would be consumed during the same period for assuring an average indoor temperature of 20 °C.

Given an external temperature T_e = – 4.2 °C, and indoor temperatures in our case (see Fig. 4), the indices,

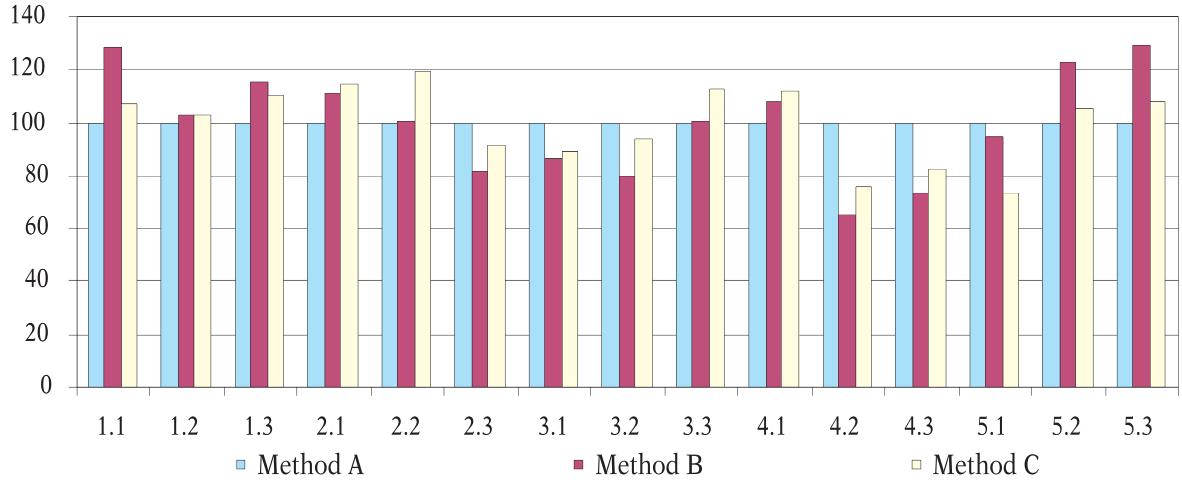


Fig. 5 Comparison between the three usual heat-billing methods

calculated with Equation (1) are given in Fig. 6a. In order to obtain an accurate idea of relative levels of comfort, the indices must be related to their average value. In Fig. 6b the relative indices of the thermal comfort level are given. Their values are very close to the consumption indices calculated by Method C (see Fig. 4a).

Practically, it is very difficult to measure the external temperature (T_e) available for each room or even for each apartment. Instead, one can use statistical data, usually available for each locality, in national norms [9]:

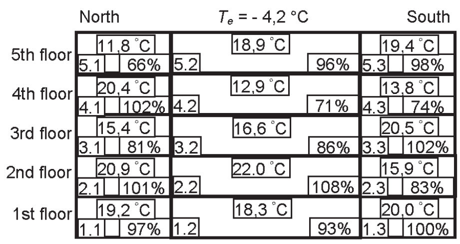


Fig. 6a Thermal comfort level indices based on actual external temperatures: Absolute values

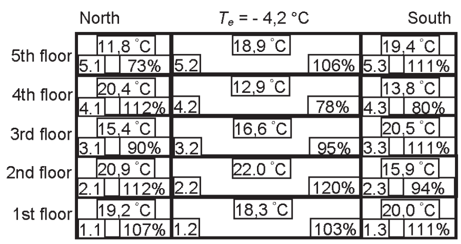


Fig. 6b Thermal comfort level indices based on actual external temperatures: Relative values

the *multi-annual average external temperature* (T_{em}) and the *number of degrees-days in the heating period* (N_{12}^{20}). In Table 1 some such statistical data is presented, together with the number of heating days *(D)* for Bucharest.

According to the Romanian norm [9], the *number of degrees-days in the heating period* (N_{12}^{20}) is the addition of the differences between the reference temperature (20 °C) and the multi-annual average of daily external temperatures lower than 12 °C.

By using these statistical data, we could calculate the indices of thermal comfort level in two different formats. The first one (Equation 2) is an "instantaneous" format (the average value of the thermal comfort level index is continually available):

$$I_{TCLi} = \frac{\int (T_{Room} - T_{em})\, d\tau}{\int (20 - T_{em})\, d\tau}\, 100 \qquad (2)$$

The second format (Equation 3) is a "cumulative" format. The value of the thermal comfort level index is available at the end of the period, only:

$$I_{TCLe} = \frac{\int (T_{Room} - T_{em})\, d\tau}{N_{12}^{20}}\, 100 \qquad (3)$$

In both formats the thermal comfort level index is a quantity indicating practically how far removed the actual thermal comfort of a particular room is from its level of reference. Usually an indoor temperature of 20 °C gives this level of reference. Since the inhabitant himself voluntarily controls the internal temperature,

Month	X	XI	XII	I	II	III	IV
T_{em}(°C)	10.1	5.2	0.2	– 2.4	– 0.1	4.8	10.4
D	19.9	30	31	31	28.25	31	18.9
N_{12}^{20}	197	444	613.8	694.4	567.8	471.2	205.8

Table 1 Multi-annual statistical data according to SR 4839:1997

the thermal comfort level index is a fully objective measure of its energetic behavior. Irrespective of the size of the room and its orientation, the thermal comfort level index will have a value lower or higher than 100. Therefore, this value will always provide a comprehensive image of the energetic behavior voluntarily adopted by the inhabitant over a certain period.

Considering the external average temperature $T_{em} = -2.4$ °C (drawn from the Romanian Norm for Bucharest in January) and the same indoor temperatures as in Fig. 6, the thermal comfort level indices, calculated with Equations (2) or (3) are shown in Fig. 7.

The chart in Fig. 8 confirms that the values calculated by Equations (2) or (3) are very similar to those calculated using Method C.

Reliability

Our studies concluded that taking as references the pair of values (N_{12}^{20} , T_{em}) is a very reliable solution. The number of degrees-days is a consistent value, already officially used for evaluating the heat necessary. In fact, Equations (1), (2) and (3) confirm the generally known rule stating that a reduction of 1 °C induces an energy saving of 6 % [6]. The charts in Figs. 9a and 9b demonstrate this assertion, comparing the official value (N_{12}^{20}) with four particular heat consumptions in two kinds of buildings, for two different years. It is clear that there is a decreasing tendency towards consumption in individual houses when improvements are made to the thermal insulation and in the energetic behavior. On the contrary, in the block of flats the consumption remains constant, because of the lack of individual heat metering and billing.

Also, the chart in Fig. 9c shows the strong correlation between the gas consumption of an individual house and the average multi-annual number of degrees-days expressed in m^3/day.

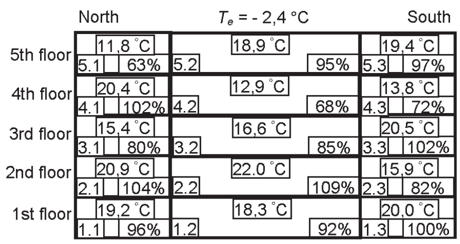


Fig. 7a Thermal comfort level indices based on multi-annual statistical data: Absolute values

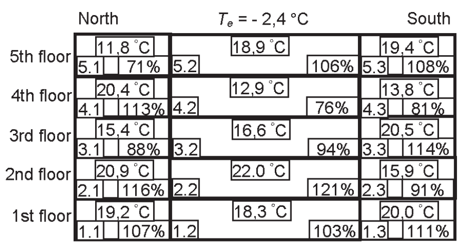


Fig. 7b Thermal comfort level indices based on multi-annual statistical data: Relative values

The TCL billing method

For a particular apartment, the TCL billing method corrects the cost per square meter with a factor, proportional to the index of thermal comfort level [10,11]. This index is given by the addition of individual weighted indices, measured in all heated rooms of the apartment.

The method could be described by four initial phases (installing instruments - setting initial data - evaluating the weights of the floor areas - personalizing each instrument) and three cyclic phases (measuring - reading - billing). In Fig. 10 an example is shown of a calculation of the index in a particular apartment, by weighting the rooms' indices according to their floor areas weights.

Like methods B and C, the TCL Method can be used in conjunction with Method A, that is every consumer has to pay partially according to the floor area and partially based on the readings of the allocators (50–70 % of the total heating costs). Heat or fuel and its delivery costs, electricity, operation and maintenance costs, regular testing, cleaning of equipment and boiler

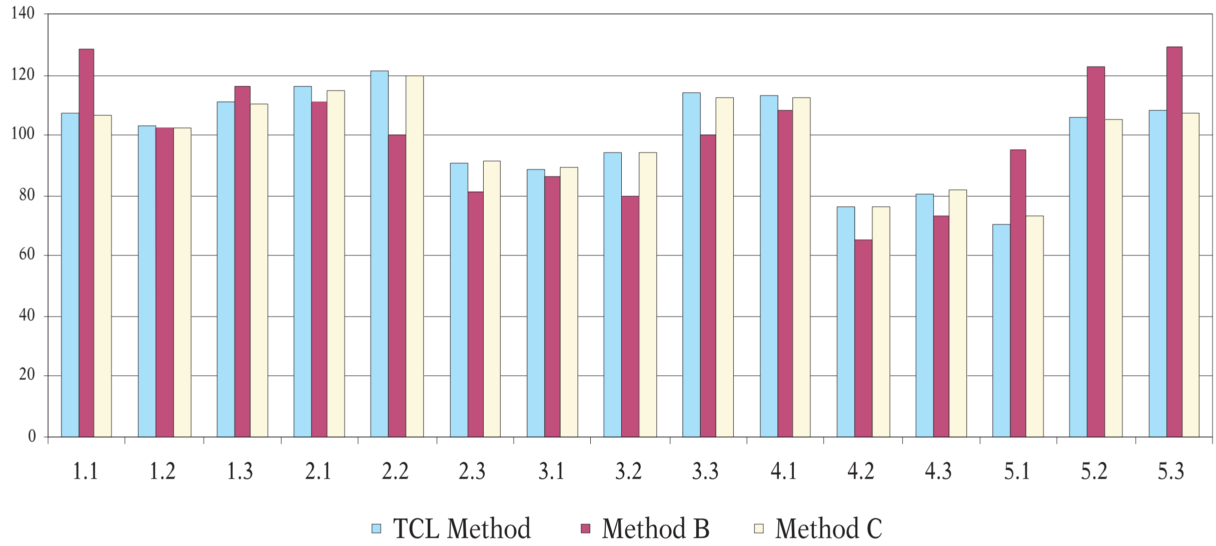


Fig. 8 Comparison of the three heat billing methods based on metering

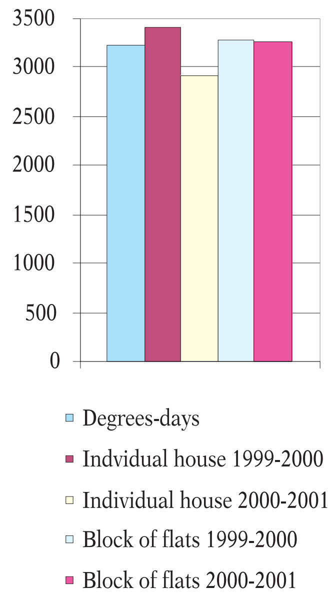


Fig. 9a Reliability of the TCL billing method: Multi-annual number of degrees-days vs. heat consumption

room maintenance, etc., can be included in the total heating costs.

The intention of the TCL Method is not to dispense with the classical methods, but rather to propose an alternative way of reaching similar objectives. It can increase consumer motivation in reducing costs by using simpler and more efficient tools (see Fig. 11). Advantageously, it does not depend on the type, size and shape of the radiator and it can be used not only for radiators, but also for other heat emission systems such as floor heating, ceiling radiation, convectors or air conditioning systems. By applying correction factors "into reverse sense", the method still provides actual consumption indices.

The instrument

An instrument using the *"thermal comfort level"* principle (HCA-TCL) requires only two measured quantities as inputs (the indoor temperature and the temperature of the flow pipe) and several memorized data (monthly temperatures / numbers of degrees-days, volumes / surfaces of heated rooms, time and date, etc.). For each month of the heating period, the measurement results are memorized in separate registers [10,11].

In its most simple form, the HCA-TCL is a specialized electronic circuit protected by a small box installed by means of a collar on the supply pipe (Fig. 12a). Pressing the two buttons displays the indices over the last twelve months and also other measurement data. A wall-mounted version of the instrument could be designed, although an electrical connection to the flow pipe would be necessary. A more complex configuration would be a combination with a thermostatic radiator valve (Fig. 12b). This instrument performs not only metering, but also individual heating control.

Since the instrument indication is easy to understand, the tenants themselves could make the monthly readings, under administrator supervision. In our example, the index 63.4 shows an excellent energetic behavior measured during the month of January. However, in a more complex version the system could be equipped with a radio M-Bus or a remote reading.

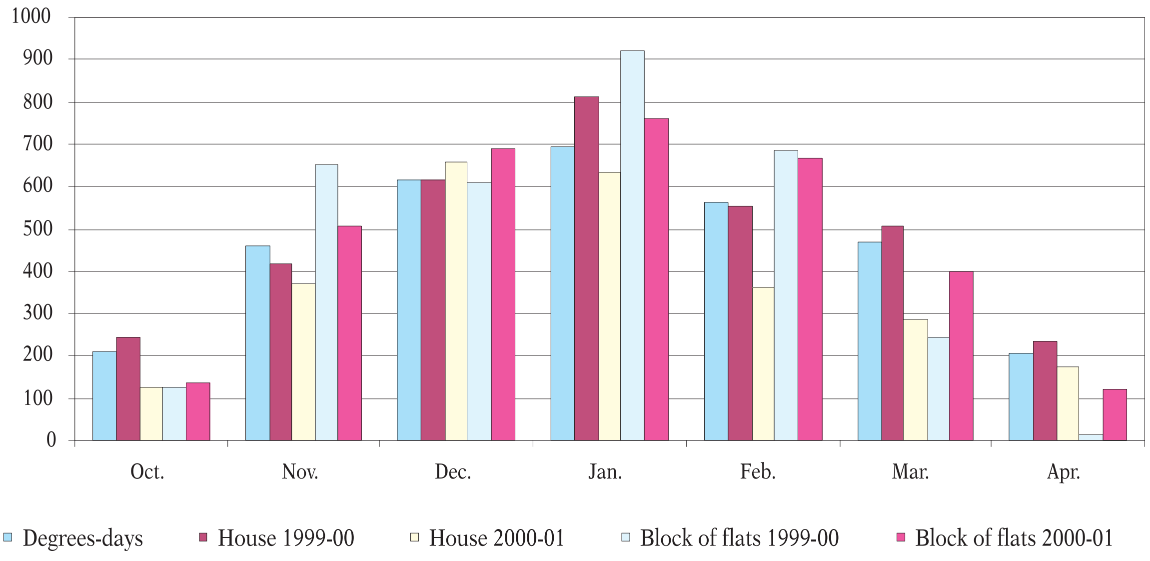


Fig. 9b Reliability of the TCL billing method: Monthly distribution of number of degrees-days vs. heat consumption

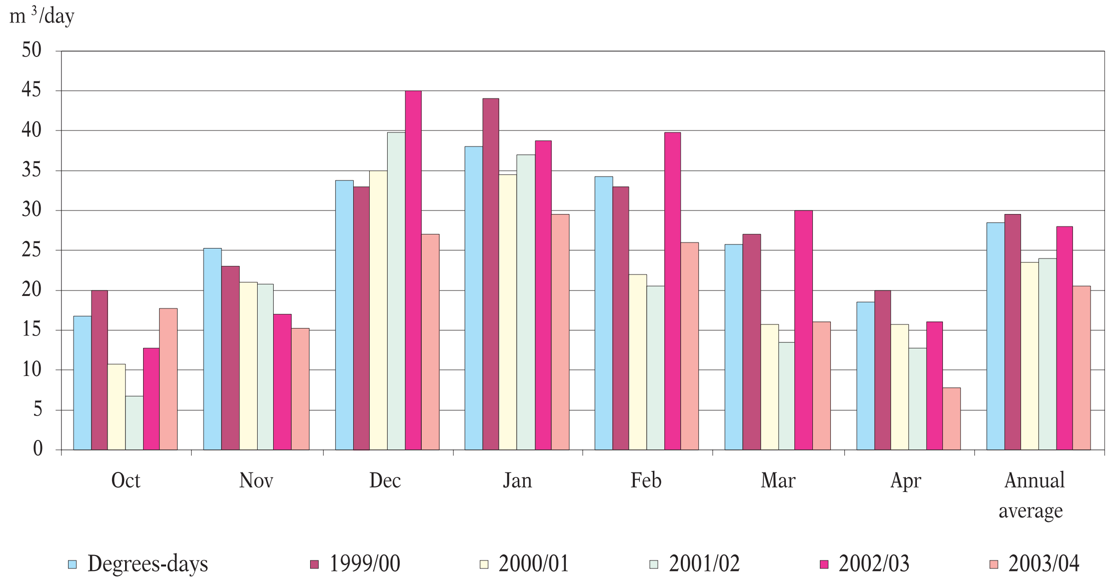


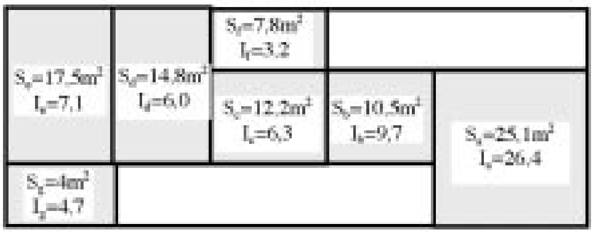
Fig. 9c Reliability of the TCL billing method: Average daily gas consumption in an individual house

Metrological approaches

Heat metering and billing is performed with two categories of devices: heat meters (according to OIML R 75 and EN 1434) and heat cost allocators. Even if the heat cost allocators do not measure in physical units (like heat meters), they are nevertheless sophisticated and sensitive measuring instruments. The classical allocators have to fulfill the minimum requirements of European Norms EN 834 and EN 835. The maximum permissible errors are ± 8 % during calibration tests in the laboratory (intrinsic errors) and ± 16 % (in use errors) [8,12].

Since the intrinsic errors depend on the construction type (evaporative or electronic, with one or two temperature sensors, etc.), the errors in practical applications of classical allocators depend on a number of factors, such as [5]:

a) shape, size and material of radiators;
b) operating position of the radiators (wall-mounted, “in niche”, hidden, cold surfaces nearby, inlet/outlet position);
c) quality of thermal contact between sensors and radiators;



T_e= – 2.4 °C; N = 658 degrees-days; I_{TCL} = ***63.4***

Fig. 10 Thermal comfort level indices in a particular case

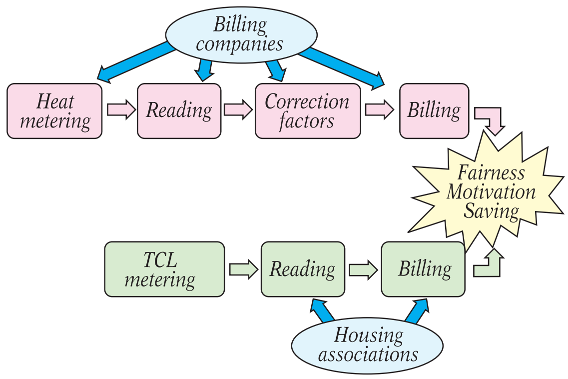


Fig. 11 TCL Method vs. classical methods - reaching similar results in two different ways

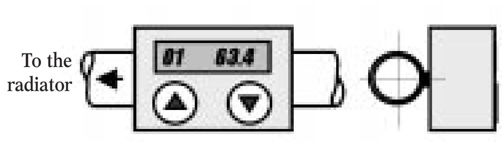


Fig. 12a Possible configurations for HCA-TCLs: HCA-TCL installed on a heating pipe (consumption index 63.4 for January)

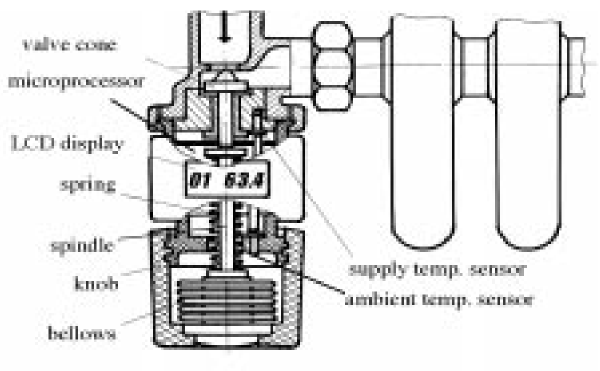


Fig. 12b Possible configurations for HCA-TCLs: HCA-TCL built inside a thermostatic radiator valve (THRV)

d) position on the radiator surface;
e) fulfillment of temperature range;
f) flow rate variation.

On the other hand, the fairness of the heat billing strongly depends on:

a) accuracy of data reading and processing;
b) errors in the evaluation of compensation factors for particular locations of the rooms in the building;
c) possible fraudulent interventions.

We can assume that, due to their simplicity, the TCL Method and instrument could have better intrinsic errors than classical allocators. On the other hand, since there is no correlation between radiators and HCA-TCLs, the errors in practical applications can be much lower. There are some influence factors, but most of these act in a similar manner for all consumers and therefore the fairness of the billing is not significantly affected. Special attention has been paid to opening of windows and to additional heat sources. In order to compensate for the effect of these influence factors, some simple solutions are available. Advantageously, the particular locations of the rooms are automatically compensated for by the TCL Method itself and the effect of possible fraudulent interventions can be easily minimized.

Possible impact of the implementation

The implementation of the TCL Method and use of the instrument in Romania could lead to energy savings of 30–35 %, if used in conjunction with thermostatic valves. Since the constructive solution of the HCA-TCL is simpler and the installation, use and billing do not require special skills, the estimated cost-effectiveness is much higher.

The advantages for customers result from the following essential differences between classical electronic allocators and the HCA-TCL:

1. The HCA-TCL can be used not only for radiators, but also for other heat emission systems such as floor heating, ceiling radiation or convectors.
2. Since classical allocators measure an “insensitive” quantity (proportional to the emitted heat), the HCA-TCL provides the thermal comfort level index that is a very “sensitive” quantity.
3. Classical allocators always display some “incomprehensible” figures to the customer. Their use requires extensive knowledge and special skills for billing provided by specialized companies. These companies collect the data and “process” them by applying certain correction factors (e.g. exposition factors,

28, Moon Str.						
Month: January 2004						
Total cost of heat - ROL: 25 803 025						
Ap. no.	Heated area mp	TCLa %	TCLr %	**Individual cost of heat - ROL** On area	On HCA	**Total**
1.1	85.5	96.4	108.73	475 294	1 205 838	**1 681 132**
1.2	107.5	92.4	104.22	597 592	1 453 203	**2 050 795**
1.3	85.5	100	112.79	475 294	1 250 869	**1 726 164**
2.1	85.5	104	117.3	475 294	1 300 904	**1 776 198**
2.2	107.5	108.9	122.83	597 592	1 712 703	**2 310 296**
2.3	85.5	81.7	92.15	475 294	1 021 960	**1 497 255**
3.1	85.5	79.5	89.668	475 294	994 441	**1 469 735**
3.2	**107.5**	**130**	**146.63**	**597 592**	**2 044 549**	**2 642 142**
3.3	85.5	102.2	115.27	475 294	1 278 388	**1 753 683**
4.1	85.5	101.8	114.82	475 294	1 273 385	**1 748 679**
4.2	107.5	68.3	77.036	597 592	1 074 175	**1 671 767**
4.3	85.5	72.3	81.547	475 294	904 378	**1 379 673**
5.1	**85.5**	**0**	**0**	**475 294**	**0**	**475 294**
5.2	107.5	95.1	107.26	597 592	1 495 666	**2 093 259**
5.3	85.5	97.3	109.75	475 294	1 217 096	**1 692 390**
Average		88.66	100			
Total	1392.5			7 740 907	18 062 118	**25 803 025**

Fig. 13 A typical heat billing case according to the TCL Method

etc.). On the other hand, HCA-TCLs directly provide "natural" allocation indices as values lower or higher than 100. The reference value of 100 always gives the "normal" thermal comfort level for that locality during each particular month. The table in Fig. 13 demonstrates the simplicity of the billing that can be achieved even by the housing association itself. In our example there are only two special cases: apartment no. 3.2 (no HCAs installed) and apartment no. 5.1 (the tenant opted out of the district heating services). For these exceptional cases the billing method automatically charges tenants using consumption indices obtained by the administrative method (0 and 130, respectively).

4. Classical allocators must be installed on the radiator surface only in a precise position, but the HCA-TCL could be mounted on the heating pipe, on the wall or even inside a thermostatic radiator valve.
5. For a classical allocator it is very important to have specific information concerning the radiator itself (shape, dimensions, position, etc.). With the HCA-TCL, there is no need to know these data.

Conclusions

1. The increase in energy costs in Romania and other Eastern European countries has to be accompanied by appropriate means in order to limit the economic and social impact of high costs. An efficient heat billing method could be one of the methods used.
2. By using the TCL billing method, *objective* "measures" of certain *subjective* quantities such as energetic behavior, thermal comfort, etc. can be performed.
3. The TCL billing method does not intend to dispense

with the "classical" methods, but it seems to be the most appropriate alternative for Romania and other Eastern countries.

4. The TCL billing method and its appropriate instrument can significantly limit or even eliminate heat wastage, poor energetic behavior, the tendency towards opting out of the district heating services, conflicts between residents and authorities, etc.
5. The significant cost of the development of the TCL billing method and instrument can be totally offset by the huge potential of the market, and by substantial energy savings.

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The Author welcomes comments to his article and can be contacted as below:

Paul Darvariu
Romanian Bureau of Legal Metrology (BRML)
Technical Department
Sos. Vitan Barzesti nr. 11 Sector 4
042122 Bucuresti, Romania
E-mail: drn@brml.ro
darvariu@hotmail.com

MASS STANDARDS

Dissemination of the mass unit from 1 kg reference standards to weights of Class E_1 between (1...10) kg

ENG. ADRIANA VÂLCU
BRML (National Institute of Metrology), Romania

PROF. DR. ENG. CONSTANTIN MILITARU
University "Politehnica" of Bucharest, Romania

Abstract

The realization, maintenance and dissemination of the SI base unit the kilogram *is one of the tasks of the INM Mass Laboratory and is carried out by means of reference standards which are traceable to the International Kilogram Prototype through the mass of the National Prototype No.2.*

This paper describes the dissemination of the mass unit from 1 kg reference standards to weights of Class E_1 between (1...10) kg and deals with the new link of standards (using the Romanowski model), by means of which the mass scale of the INM is achieved, in the above-mentioned range.

The mass standards, equipment used for the comparisons, calculations, results and the associated uncertainties for all the weights involved are also described.

1 Introduction

Romania obtains the value of the 1 kg mass unit from the BIPM (Sèvres, France), by means of the National Prototype Kilogram No. 2. It is the INM's task to propagate the Romanian mass scale by subdivision or multiplication from the kilogram level.

Class E_1 weights ensure traceability between the national mass standard (its value being derived from the International Kilogram Prototype) and weights of Class E_2 and lower [1]. They are used as reference standards by the Regional Romanian calibration laboratories.

2 Test procedures

The set (10...1) kg of Class E_1 weights usually consists of 10 kg, 5 kg, 2 kg, 2^* kg, and 1kg weights. By the method of least squares adjustment, the unknown masses and their standard deviations are calculated.

Weighing is always performed as substitution weighing; this means that single weights or combinations of weights are always compared with another combination of the same nominal value.

The difference between the balance indications has the symbol Δm and it is necessary to apply air buoyancy corrections to the observed weighing differences.

If "y" is the new corrected difference, this gives:

$$y = \Delta m + (\rho_a - \rho_o)(V_1 - V_2) \qquad (2.1)$$

where:

y = the corrected indication
Δm = the difference in balance readings calculated from one weighing cycle (RTTR) to eliminate possible linear drifts of the balance readings
ρ_o = 1.2 kg·m^{-3}, the reference air density
ρ_a = air density at the time of the weighing and
V_1, V_2 are the volumes of the standards (or the total volume of each group of weights) involved in the measurement.

The observations are of the same accuracy (for all mass comparisons only one comparator was used in the calibration). One weighing series comprises six weighing cycles.

The system of equations, which is an orthogonal one (i.e. the covariances are equal to zero), is as follows:

$$\begin{aligned}
&(10) = M\\
&-(10) + (5) + (2) + (2^*) + (1) = y_1\\
&-(10) + (5) + (2) + (2^*) + (1^*) = y_2\\
&(5) - (2) - (2^*) - (1) = y_3\\
&(5) - (2) - (2^*) - (1^*) = y_4\\
&(2) - (2^*) + (1) - (1^*) = y_5\\
&(2) - (2^*) + (1) - (1^*) = y_6\\
&(2) - (2^*) - (1) + (1^*) = y_7\\
&(2) - (2^*) - (1) + (1^*) = y_8\\
&(2) - (1) - (1^*) = y_9\\
&(2) - (1) - (1^*) = y_{10}\\
&(2^*) - (1) - (1^*) = y_{11}\\
&(2^*) - (1) - (1^*) = y_{12}
\end{aligned} \qquad (2.2)$$

To convert the natural system into an orthogonal one, the following sentence has been taken into account: *"an orthogonal system of equation of condition can be formed only if the defining weight that is included in the system has the largest mass"* [5]. For this reason, the preliminary equation of the definition is introduced into the system (eq. 2.2).

During calibration of multiples, the role of "M" is assigned to a different mass: for the largest mass and for the smallest one [6].

It is assumed that the mass of (10) defines a temporary mass unit "r", where (10) = M = 10 r and the other weights are expressed. From the system of normal equations the next normal equation in (1) is used:

$$10(1) = 10\,r + N \tag{2.3}$$

N represents the sum of measured values in which (1) is involved and has the form:

$$N = y_1 - y_3 + y_5 + y_6 - y_7 - y_8 - y_9 - y_{10} - y_{11} - y_{12} \tag{2.4}$$

The value of (1) was determined by a direct comparison against the National Prototype No 2; its value is introduced in eq. 2.3; "r" and (10) = 10 r can be further calculated. The value of (10) is used to begin the calculation of the other weights and once all the weighings are completed, the first step consists in the formation of the design matrix.

Matrix "X" contains the information on the equations used (the weighing scheme) and matrix "Y" contains the measured differences from these equations.

Denote: $X = (x_{ij})$; I = 1…n; j = 1…k; x_{ij} = 1, – 1 or 0.

β is (β_j) the vector of unknown departures and Y is (y_i) the vector of measured values (including buoyancy corrections).

$$X = \begin{vmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 0 & 1 \\ 0 & 1 & -1 & -1 & -1 & 0 \\ 0 & 1 & -1 & -1 & 0 & -1 \\ 0 & 0 & 1 & -1 & 1 & -1 \\ 0 & 0 & 1 & -1 & 1 & -1 \\ 0 & 0 & 1 & -1 & -1 & 1 \\ 0 & 0 & 1 & -1 & -1 & 1 \\ 0 & 0 & 1 & 0 & -1 & -1 \\ 0 & 0 & 1 & 0 & -1 & -1 \\ 0 & 0 & 0 & 1 & -1 & -1 \\ 0 & 0 & 0 & 1 & -1 & -1 \end{vmatrix} \quad Y = \begin{vmatrix} y_1 + 10r \\ y_2 + 10r \\ y_3 \\ y_4 \\ y_5 \\ y_6 \\ y_7 \\ y_8 \\ y_9 \\ y_{10} \\ y_{11} \\ y_{12} \end{vmatrix} \quad \beta = \begin{vmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \\ \beta_5 \\ \beta_6 \end{vmatrix}$$

If $(X^T \cdot X)$ is the matrix of the normal equations, this gives:

$$(X^T \cdot X) \cdot \beta = X^T \cdot Y \tag{2.5}$$

where X^T is the transpose of X.

The best estimate of β, $\langle\beta\rangle$ for an over-determined system of equations "X" is given by:

$$\langle\beta\rangle = (X^T \cdot X)^{-1}\, X^T \cdot Y \tag{2.6}$$

$(X^T \cdot X)^{-1}$ is termed the inverse of $(X^T \cdot X)$ and takes the form:

$$(X^T \cdot X)^{-1} = \begin{vmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.25 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.1 \end{vmatrix} \tag{2.7}$$

3 Example of a least-squares analysis

3.1 Equipment, standards and results

3.1.1 Equipment

A CC10000 U-L comparator has been available since March 2002; this is the only comparator that has been used for all comparisons and consequently the observations are of the same accuracy.

Comparison weighings are carried out completely automatically and measurement data are gathered, evaluated and recorded.

A precise "climate station" system YCM02C is used for accurate determination of air density. This system consists of a data collection unit with a built-in power supply, a precision sensor for barometric pressure, an electrical aspiration pshychrometer, and data evaluation software for installation in a PC. The technical requirements for the YCM02C are:

Temperature:	Measuring range: (0...40) °C Readability: 0.01 K U (k=2): 0.1 K
Relative humidity:	Measuring range: (0...100) % Resolution: 0.1 % U (k=2): 1.0 %
Barometric pressure:	Measuring range: (35...1310) hPa Readability: 0.1 hPa U (k=2): 0.25 hPa

From the air parameters, the air density is calculated using the equation recommended by the CIPM [2].

3.1.2 Standards and results

For the calibration, a 1 kg reference standard (whose value is determined by direct comparison against the National Prototype No. 2) is used as the known mass. The result of this comparison (conventional mass) was:

m_r = 0.999 996 802 kg　　　$U(m_r)$ = 0.048 mg (k=2).

For this reference standard, the certificate also gives:

V = 127.7398 cm^3　　　U_v = 0.0012 cm^3 (k=2).

The observed mass differences read:

$$Y = \begin{vmatrix} -0.6422 \\ -1.8487 \\ 1.5166 \\ 3.4411 \\ 0.2047 \\ -3.3207 \\ -3.2885 \\ 3.2778 \\ 3.2473 \\ 3.3670 \\ 3.3856 \\ 3.4244 \\ 3.4089 \end{vmatrix} \qquad (3.1)$$

The vector $\langle\beta\rangle$ with the unknown masses, according to equation (2.6) described above, gives:

$$\langle\beta\rangle = \begin{vmatrix} 10\,kg - 0.64\text{ mg} \\ 5\,kg + 0.81\text{ mg} \\ 2\,kg + 0.27\text{ mg} \\ 2^*kg + 0.30\text{ mg} \\ 1\,kg - 3.198\text{ mg} \\ 1^*kg + 0.09\text{ mg} \end{vmatrix} \qquad (3.2)$$

4 Analysis of uncertainties

4.1 Type A uncertainty

If the adjusted mass difference of the weighing equations is $\langle Y\rangle = X \cdot \langle\beta\rangle$, the residual for each equation is calculated as follows:

$$res_i = Y_i - \langle Y_i\rangle = \begin{vmatrix} 0.039 \\ 0.039 \\ 0.025 \\ 0.025 \\ 0.009 \\ 0.034 \\ 0.016 \\ 0.015 \\ 0.017 \\ 0.004 \\ 0.015 \\ 0.018 \end{vmatrix} \qquad (4.1)$$

If each mass difference Y_i is determined from n_i repeated weighing cycles RTTR with the standard deviation s_i (of the mean value Y_i), a better estimate of the group standard deviation "s" is calculated as follows [3]:

$$s^2 = [\Sigma(s_i^2(n_i - 1)/n_i + res_i^2) \cdot W_i] / f \qquad (4.2)$$

where:

f = number of the degrees of freedom: $f = (\Sigma n_i - k)$
n_i = the number of repeated weighing cycles
k = numbers of the unknown parameters
W, the weighting factor, is calculated as follows:

$$W = n_i\,(s_{bal}^2/s_i^2) \qquad (4.3)$$

According to equation (4.2) the group standard deviation is:

s = 0.0289 mg

The variance - covariance matrix for $\langle\beta\rangle$ is given by:

$$V_\beta = s^2(X^T \cdot X)^{-1} \qquad (4.4)$$

$$V_\beta = 0.0008351 \cdot \begin{vmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.25 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.1 \end{vmatrix} \qquad (4.5)$$

Where the variances on the values of the solutions $\langle\beta\rangle$ are given by the diagonal elements of the matrix $(X^T \cdot X)^{-1}$ denoted with c_{ij}. The off-diagonal elements of the matrix give the covariance between the weights.

The standard deviation (uncertainty of type A) of a particular unknown weight is:

$$u_{A(\beta j)} = s\sqrt{c_{ij}} = \begin{vmatrix} 0.029 \\ 0.014 \\ 0.0091 \\ 0.0091 \\ 0.0091 \\ 0.0091 \end{vmatrix} \text{ mg} \quad (4.6)$$

4.2 Type B uncertainty

The components of type B uncertainties are as below.

4.2.1 Uncertainty associated with the reference standard

The uncertainty of the reference standard comprises a component from the calibration certificate, and another component from the variance - covariance matrix and from its drift (stability of the standard).

Regarding the uncertainty associated with the stability of the standard: this calculation is to regard a change in value between calibrations as a rectangular distribution. This component would be equivalent to the change between calibrations divided by √3. If the change from the last calibration was 0.02 mg, then the uncertainty is 0.02/√3 = 0.011 mg.

The uncertainty of the reference standard will be:

$$u_{mr} = \sqrt{0.024^2 + 0.0091^2 + 0.011^2} = 0.0279 \text{ mg} \quad (4.8)$$

$$u_{r\,(\beta j)} = h_j \cdot u_{mr} = \begin{vmatrix} 10r \\ 5r \\ 2r \\ 2r \\ r \end{vmatrix} = \begin{vmatrix} 0.279 \\ 0.139 \\ 0.056 \\ 0.056 \\ 0.0279 \end{vmatrix} \text{ mg} \quad (4.9)$$

where h_j is the ratio between the nominal values of the unknown weights β_j and one of the reference m_r.

4.2.2 Uncertainty associated with the air buoyancy corrections

$$u_b^2{}_{(\beta j)} = (V_j - h_jV_r)^2 \cdot u^2_{\rho a} + (\rho_a - \rho_o)^2\,(u^2_{Vj} + h_ju^2_{Vr}) \quad (4.10)$$

where:

V_j ,V_r = the volume of the test weight and the reference standard, respectively

$u_{\rho a}$ = the uncertainty for the air density

ρ_o 1.2 kg·m^{-3} = the reference air density

u^2_{Vj}, u^2_{Vr} = the uncertainty of the volume of the test weight and the reference standard, respectively.

$$u_{b\,(\beta j)} = \begin{vmatrix} 0.006 \\ 0.003 \\ 0.001 \\ 0.001 \\ 0.001 \\ 0.0003 \end{vmatrix} \text{ mg} \quad (4.11)$$

4.2.3 Uncertainty due to the center of gravity correction

This correction is applied to the mass difference obtained (eq. 2.2) and its formula is [9]:

$$C_g = m \cdot \gamma \cdot \delta h/g \quad (4.12)$$

where:

m = the nominal value of the weight

γ = the gravitational gradient: $\gamma = 3.086 \cdot 10^{-6}$ m·s^{-2} · m^{-1}
U = 2 · 10^{-8} m·s^{-2}·m^{-1}

g = the acceleration due to gravity: g = 9.805 396 m/s^2
U = 2 · 10^{-6} m/s^2

δh = the difference in the height of the centers of gravity

The table below shows the corrections due to the different centers of mass levels "δh" for the comparison between mass standards and combinations of mass standards of nominal values M_r and M_j.

M_r	M_j	δh	C_g µg	u_{cg} µg
Σ 10	10	16.1	+ 50.6	0.006
5	Σ 5	19.4	– 30.5	0.002
2 + 1	2 + 1	0	0	0.000
2	Σ 2	8.9	– 5.6	0.002

The uncertainty in the height of the center of gravity is less than 2 mm. An error of 2 mm in the height leads to a systematic error in the mass which is not significant in the context of the kilogram uncertainty budget.

4.2.4 Uncertainty due to the display resolution of a digital balance

For a digital balance with scale interval d = 0.01 mg, the uncertainty due to the resolution is [1]:

$$u_r = \left(\frac{d/2}{\sqrt{3}}\right) \times \sqrt{2} = 0.0041 \text{ mg} \quad (4.13)$$

4.2.5 Uncertainty due to the sensitivity of the balance

If the balance is calibrated with a sensitivity weight (or weights) of mass, m_s, and of standard uncertainty, $u(ms)$, the uncertainty contribution due to sensitivity is:

$$u_s^2 = \Delta m_c^2 \cdot [u_{ms}^2 / m_s^2 + u^2 (\Delta I_s) / \Delta I_s^2] \quad (4.14)$$

where:

ΔI_s = the change in the indication of the balance due to the weight sensitivity
$u(\Delta I_s)$ = the uncertainty of ΔI_s
Δm_c = the average mass difference between the test weight and the reference weight.

This uncertainty component is not significant in the context of the kilogram uncertainty budget.

4.3 Combined standard uncertainty

The combined standard uncertainty of the conventional mass of the weight βj is given by:

$$u_{c(\beta j)} = [u_A^2(\beta j) + u_{mr}^2(\beta j) + u_b^2(\beta j) + u_r^2 + u_s^2 + u_{cg}^2]^{1/2} \quad (4.15)$$

The summation contains all the contributions described above.

$$u_{c(\beta j)} = \begin{vmatrix} 0.280 \\ 0.140 \\ 0.057 \\ 0.057 \\ 0.031 \end{vmatrix} \text{ mg} \quad (4.16)$$

4.4 Expanded uncertainty

The expanded uncertainty U (with k=2) of the conventional mass of the weights βj is as follows [8]:

$$U = k\, u_{c(\beta j)} = 2 \cdot \begin{vmatrix} 0.280 \\ 0.140 \\ 0.057 \\ 0.057 \\ 0.031 \end{vmatrix} = \begin{vmatrix} 0.56 \\ 0.28 \\ 0.11 \\ 0.11 \\ 0.06 \end{vmatrix} \text{ mg} \quad (4.17)$$

5 Uncertainty budget

The table on page 19 shows the results obtained from the least squares analysis of the weighing data and their associated uncertainties. It also lists the contribution due to the uncertainty in the value of the standard, in the buoyancy correction, the centre of gravity and in the balance.

6 Implications for legal metrology

Calibration of weights of Class E_1 ensures traceability between the National Mass Standard and weights of Class E_2 and lower, up to weights of Class M_1 and M_2.

According to ISO 9000 and ISO/IEC 17025, "traceability of measuring and test equipment to the realization of SI units must be guaranteed by an unbroken chain of comparison measurements to allow the necessary statements about their metrological quality".

Weights of Class E_1 are used as reference standards at the Regional Romanian Calibration Laboratories. For this reason, their calibration provides the technical basis for metrological verification and conformity assessment, thus ensuring the traceability and comparability of measurement results both in legal and industrial metrology in our country.

Confidence in measurement results is therefore achieved by establishing a traceability route to the SI Unit and by indicating the uncertainty of the measurement results, leading to appropriate, recognized and reliable measurements to protect both people and the environment.

7 Conclusions

A calibration scheme for mass standards from (1 ...10) kg has been described. The test procedure described led to an efficient calibration of sets of Class E_1 weights in the said range, these weights also being used to calibrate laboratory standards with lower uncertainty.

The weighing scheme and the automatic electronic mass comparator used have led to an appreciable reduction in uncertainty in each mass value, compared with previous calibrations. ■

Author's e-mail: adriana@inm.ro

Uncertainty component	(Standard) uncertainty contributions (mg)					
	10 kg	5 kg	2 kg	2*kg	1 kg ref	1 kg
$u_{mr} \cdot h_j$ in mg	0.279	0.139	0.056	0.056	0.0279	0.0279
$V_r \cdot h_j$ in cm^3	1277.398	638.699	255.480	255.480	127.7398	127.7398
$u_{Vr} \cdot h_j$ in cm^3	0.006	0.003	0.0012	0.0012	0.0006	0.0006
V_j in cm^3	1249.36	623.96	249.54	249.55	-	124.86
u_{Vj} in cm^3	0.2	0.1	0.04	0.04	-	0.02
ρ_a mg/cm^3	1.1713	1.1701	1.195	1.195	-	1.195
$U_{\rho a}$ mg/cm^3	0.0001					
$(V_j - V_r h_j)u_{\rho a}$ in mg	$7.86 \cdot 10^{-6}$	$2.17 \cdot 10^{-6}$	$3.53 \cdot 10^{-7}$	$3.52 \cdot 10^{-7}$	-	$8.29 \cdot 10^{-8}$
$(\rho_a - \rho_o)(u^2_{Vj} + u^2_{Vr})^{1/2}$mg	$3.3 \cdot 10^{-5}$	$9.01 \cdot 10^{-6}$	$1.60 \cdot 10^{-7}$	$1.60 \cdot 10^{-7}$	-	0
u_b in mg	0.006	0.003	0.0007	0.0007	-	0.0003
u_{rez} in mg	0.004					
u_A in mg	0.029	0.014	0.0091	0.0091	-	0.0091
u_{cg} in mg	0.006	0.002	0.002	0.002	-	-
u_s in mg	$6 \cdot 10^{-6}$	$1.7 \cdot 10^{-5}$	$1.6 \cdot 10^{-5}$	$1.6 \cdot 10^{-5}$	-	$1.5 \cdot 10^{-5}$
u_c in mg	0.280	0.140	0.057	0.057	-	0.031
k	2					
U in mg	0.56	0.28	0.11	0.11	0.028	0.06

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TERMINOLOGY

History and worldwide use of the term "Weights and Measures"

DR. DETLEV MENCKE

History

From the very beginning of trade with agricultural goods and the surveying of fields about 5000 years ago in Babylon and Egypt, authorities around the world had (and indeed still have) a great interest in supervising the accuracy of the *Weights and Measures* used. One of the origins of this term is mentioned in the Bible in Deuteronomy (the 5th Book of Moses, written about 3400 years ago), chapter 25, verses 13 to 15 (in the Authorized Version dated 1611):

> "Thou shalt not have in thy bag divers weights, a great and a small. Thou shalt not have in thine house divers measures, a great and a small. But thou shalt have a perfect and just weight, a perfect and just measure shalt thou have: that thy days may be lengthened in the land which the Lord thy God giveth thee."

In the New International Version of 1978 this text reads as follows:

> "Do not have two differing weights in your bag - one heavy, one light. Do not have two differing measures in your house - one large, one small. You must have accurate and honest weights and measures, so that you may live long in the land the Lord your God is giving you."

Later in the Roman Empire the Aediles (high-ranking police officers) in the towns had the right of inspection of the use of "*pondus et mensura*". These words are related to the French term "*poids et mesures*", in English *weights and measures*. Each Roman Legion received a copy of the primary standards Uncia (24.6 mm, see the English term "Inch"), Sextarius (0.547 l) and Libra (327.5 g, see the abbreviation "lb." for the English weight "Pound"). These primary standards named Exagien were deposited in the Temple of Juno Moneta in Rome [1].

In the Middle Ages, the term "*weights and measures*" was used for the whole field of legally regulated and governmentally controlled measurements and measuring instruments, nowadays called Legal Metrology. The authorities (emperors, kings, officers in town halls, etc.) proclaimed "Weights and Measures Acts" as standards in their regions.

For example, in England it was the famous Magna Carta, granted by King John in 1215. Clause 35 of this Great Charter refers to the "Regulations of *weights and measures* for wine, ale, corn and cloth". Later in 1824 the "Act for ascertaining and establishing uniformity of *weights and measures*" was published. And today the term is still in use in the United Kingdom, as one can see in the name of the responsible institute for legal metrology in the United Kingdom, "National *Weights and Measures* Laboratory" (founded in 1987).

The first country that introduced the "meter" as an exact unit for length and the "liter" as the exact unit for volume was France in 1791. The French National Convention introduced the so-called metric system in April 1795. Later in 1875 the "Comité International des *Poids et Mesures*" (International Committee of *Weights and Measures*) was founded. And the "Bureau International des *Poids et Mesures*" in Sèvres near Paris is the institute that is responsible for the realization and deposition of the fundamental units of the International System of Units.

In Germany there was for a long time great confusion as to the units used. For example in 1800 in the region of the Grand Duchy of Baden there were 123 measures for liquids and 80 pounds as standard weights in use [1]. So in 1868 some northern German counties decided to introduce the "*Maß- und Gewichts*-Ordnung für den Norddeutschen Bund" (*Weights and Measures* Acts for the North German Alliance). In 1887 the "Reichsanstalt für *Maß und Gewicht*" was founded, which became later a part of the Physikalisch-Technische Bundesanstalt (PTB).

All units worldwide currently in use are compiled in the handbook "World *Weights and Measures* – Handbook for Statisticians", published by the United Nations [2]. In the introduction of the handbook it is stated:

> "The main purpose of this volume is to provide to statisticians working in the field of international economics, factors for converting magnitudes, quantities and values from the units in which they are stated to corresponding units in any other system."

Based on the knowledge that the term "*weights and measures*" is used in many countries, and based on the fact that the author of this article made contact with many persons worldwide, it was his idea eight years ago to find out and compile a list of terms used in languages other than German, English and French. The result of the collection will be discussed later.

European languages

The biggest problem at the outset of this project was to reduce the great number of languages (more than 6000 languages and numerous dialects are used worldwide) to a reasonable number. The result of this restriction was the reduction to only those languages which are spoken in *Europe* (with some additional interesting languages such as Chinese and Japanese).

The next problem was the definition of the *Area of Europe*. As mentioned in "The New Encyclopædia Britannica" [3], the following borderline was used:

Kara Sea – Eastern Foot of the Urals – Mugodzhar Hills – Emba River – Northern Shore of the Caspian Sea – Kuma River – Kumo-Manych Depression – Manych River – Sea of Azov – Kerch Strait – Black Sea – Bosporus – Sea of Marmara – Dardanelles – Sporades (easterly of Lesbos to Rhodes) – Mediterranean (southerly of Crete and Malta) – Strait of Gibraltar – Atlantic Ocean.

So the Caucasus region, Cyprus and Greenland are not parts of Europe. It is said that the people in the Caucasus region use about 60 different languages and dialects.

On the basis of several publications concerning languages (for instance [3] and [4]) a list of 65 living European Languages was compiled. In this case, Latin is a living language, because it is the official language of the Vatican. The regions which relate to these languages (for instance those with the Gagauz, Yurak and Zyryan), will be explained later (see table below).

Germanic	Romance	Slav	Finno-Ugric
Danish	Catalan	Belorussian	Cheremis
Dutch-Flemish	French	Bulgarian	Estonian
English	Friulian	Croatian	Finnish
Faeroese	Galician	Czech	Hungarian
Frisian	Gascon	Kashubian	Karelian
High German	Italian	Macedonian	Lappish/Saamic
Icelandic	Latin	Polish	Mordvin
Luxemburgian	Occitan	Russian	Udmurt
Norwegian	Portuguese	Serbian	Zyryan
Swedish	Provençal	Slovak	
Yiddish	Romanian	Slovene	
	Romansh	Sorbian	
	Sardinian	Ukrainian	
	Spanish		
Celtic	**Turkish**	**Baltic**	**Other Languages**
Breton	Bashkir	Latvian	Albanian
Irish Gaelic	Chuvash	Lithuanian	Basque
Scottish Gaelic	Gagauz		Greek
Welsh	Kazakh		Maltese
	Tatar		Romany
	Turkish		Yurak

Sources

The author was a member of several committees, subcommittees and working groups of the OIML, ISO and CEN. In addition he participated in some OIML seminars outside of Europe. On each occasion during the last eight years when he met colleagues from other countries (members of authorities and members of industry) he asked them to add to his list of languages.

Another source was television. For example, in January 1997 German television presented the activities of a group of Bosnian people playing in a theatre in Germany on the basis of their mother tongue Romany, the language of the Gipsies (Sinti and Roma). The head of this group answered in a letter that this language did formerly not exist as a literary language, but they now use Latin letters.

In 1997 the author visited the Hanover Fair. He detected in the exhibition list three foreign companies (Latvia, Lithuania and Malta). With their help the list was again added to.

Responses given to the author by an expert of American Indian languages after a meeting in the USA were also interesting. Many Indian tribes do not have a written language, but none of them has a term for *weights and measures* in their language; they use English words.

For the time being, the collection of the term *"weights and measures"* in different languages is based on the following sources:

41 languages and dialects from members of authorities
30 languages and dialects from members of industry
4 languages with the help of television
3 languages from the Hanover Fair

78 collected (known) languages and dialects
9 unknown languages

87 listed languages and dialects

Geographical sequence

The languages and dialects are numbered from 01 to 87. Numbers 01 to 59 and 61 to 75 belong to the European languages and dialects category. Number 60 is used for Kirgiz, the language in Kirghizstan, which is located outside of Europe, but close to Kazakhstan. The latter belongs partly to Europe and partly to Asia (see the above-mentioned borderline). Numbers 76 to 87 belong to the collected non-European languages category.

The location of the region inside which people with a special language or dialect live is shown on the *Map of Europe*. Starting with number 01 for Germany (the author's homeland), the sequence follows a zigzag line

01	High German	Berlin	39	Macedonian	Skopje
02	Low German	Hamburg	40	Albanian	Tirana
03	Frisian	Emden	41	Serbian	Belgrad
04	Drents	Assen	42	Romany	Sarajewo
05	Dutch-Flemish	Amsterdam	43	Croatian	Zagreb
06	Luxemburgian	Luxemburg	44	Slovene	Ljubljana
07	English	London	45	Hungarian	Budapest
08	Scottish Gaelic	Edinburgh	46	Slovak	Bratislava
09	Manx	Isle of Man	47	Czech	Praha
10	Irish Gaelic	Dublin	48	Sorbian	Lübben (SE of Berlin)
11	Welsh	Cardiff	49	Kashubian	Gdansk
12	Cornish	Plymouth	50	Polish	Warshawa
13	Breton	Rennes	51	Yiddish	Lvov
14	French	Paris	52	Ukrainian	Kiev
15	Gascon	Bordeaux	53	Belorussian	Minsk
16	Basque	San Sebastian	54	Russian	Moscau
17	Galician	La Coruna	55	Mordvin	Saransk
18	Portuguese	Lissabon	56	Chuvash	Tscheboksary
19	Spanish	Madrid	57	Cheremis	Joschka-Ola
20	Catalan	Barcelona	58	Tatar	Kazan
21	Occitan	Languedoc	59	Kazakh	Uralsk
22	Provençal	Toulon	60	Kirgiz	–
23	Swiss German	Luzern	61	Bashkir	Ufa
24	Romansh	Chur	62	Udmurt	Ustinov
25	Tessin	Lugano	63	Zyryan	Syktyvkar
26	Austrian German	Wien	64	Yurak	Archangelsk
27	Friulian	Udine	65	Karelian	Petrozavodsk
28	Italian	Firenze	66	Finnish	Helsinki
29	Latin	Roma	67	Estonian	Tallinn
30	Corsican	Corsica	68	Latvian	Riga
31	Sardinian	Sardinia	69	Lithuanian	Kaunas
32	Sicilian	Sicilia	70	Danish	Copenhagen
33	Maltese	Valetta	71	Norwegian	Oslo
34	Greek	Athen	72	Swedish	Stockholm
35	Turkish	Ankara	73	Lappish/Saamic	Hammerfest
36	Gagauz	Chisinau	74	Faroese	Färör
37	Romanian	Bukarest	75	Icelandic	Reykjavik
38	Bulgarian	Sofia	76	Eskimo/Innuit	–

Code numbers for languages

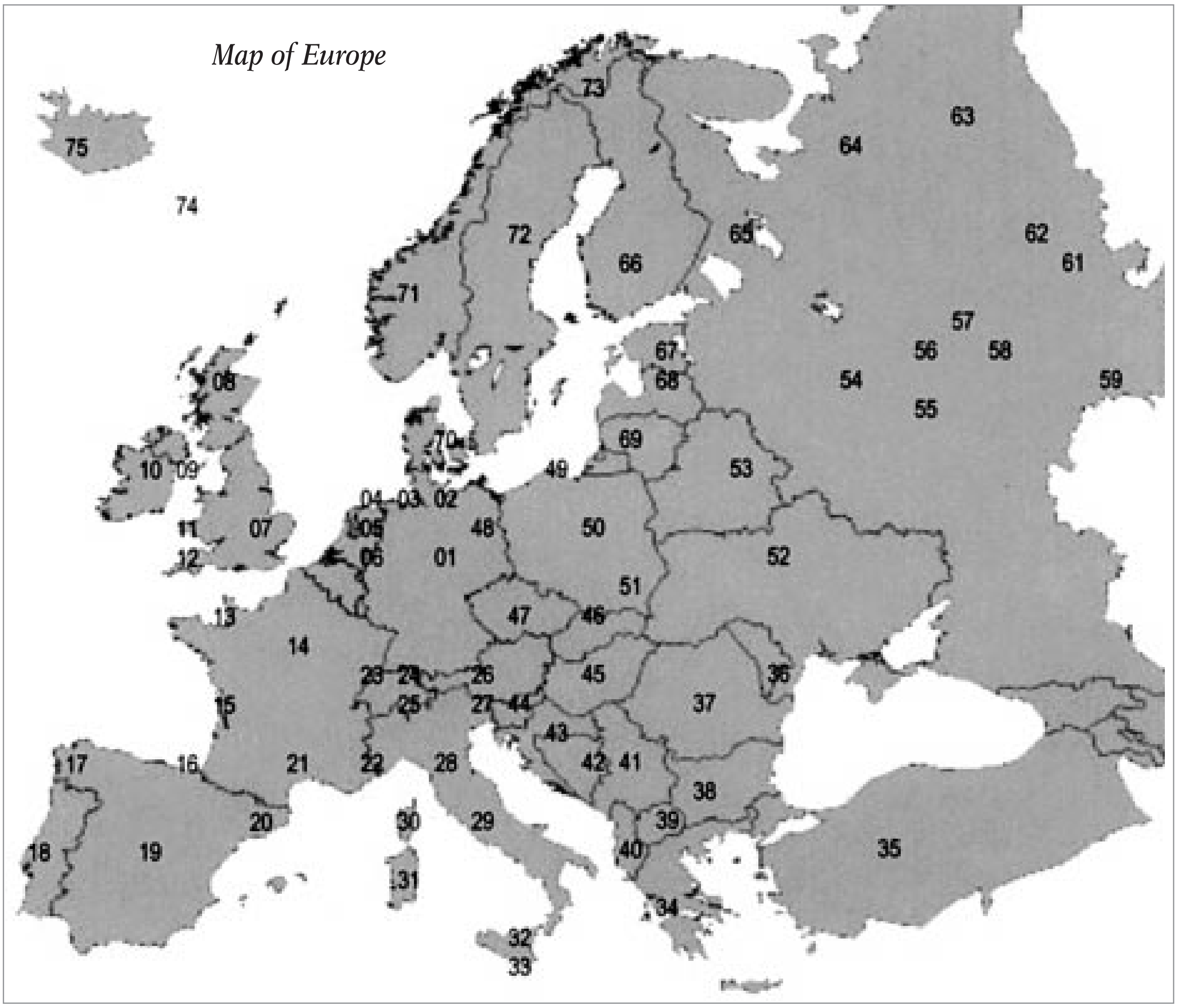
counter-clockwise from West to South and from East to North. The map does not show how many people in that region speak the language or dialect.

The result

The tables on the following pages show the term *"weights and measures"* in many languages and dialects. The table columns have the following meanings:

Column 1	Sequence number
Column 2	English name of the language or dialect
Column 3	Explanation (see table below)
Column 4	Linguistic Group or Family (see table below)
Column 5	Term "weights and measures" in that language or dialect

Please refer to the following page for further details.



Map of Europe

Abbr.	Column 3 – Explanation
1	Old writing
2	Dialect
3	Extinct language
4	Language in Canton Graubuenden in Switzerland
5	Language in Moldova
6	Language of the Gipsies (Sinti and Roma)
7	Language of the Mari in the Russian Federation
8	Language of the Komi in the Russian Federation
9	Language of the Nerzs in the Russian Federation
10	Mandarin-Chinese
Af	African language
Am	(North) American language
As	Asian language

Abbr.	Column 4 – Linguistic Group or Family
Balt	Baltic language
Celt	Celtic language
Finn	Finno-Ugric language
Germ	Germanic language
Rom	Romance language
Sem	Semitic language
Slav	Slav language
Turk	Turkish language
D-DE	German dialect
D-IT	Italian dialect
D-NL	Dutch dialect

It is interesting that both the Chinese and Japanese languages use the same three signs for the term *weights and measures*. But words in these languages which relate to these signs ("du liang heng" in Mandarin-Chinese and "do ryo ko" in Japanese), are significantly different.

01	High German	1	Germ	Maaß und Gewicht
02	Low German	2	D-DE	Maat un Wichte
03	Frisian		Germ	Mjitten en Wichten
04	Drents	2	D-NL	*Moat'n 'ne Gewicht'n*
05	Dutch-Flemish	1	Germ	Maaten en Gewigten
06	Luxemburgian		Germ	Mossen an Gewiichter
07	English		Germ	***Weights and Measures***
08	Scottish Gaelic		Celt	Cudthrom is Tomhais
09	Manx	3	Celt	*Meihaghyn as Towshanyn*
10	Irish Gaelic		Celt	Meachan agus Tómhas
11	Welsh		Celt	*Pwysau a Mesurau*
12	Cornish	3	Celt	Pōsow ha Musürow
13	Breton		Celt	Puezhioù ha Muzulioù
14	French		Rom	*Poids et Mesures*
15	Gascon		Rom	?
16	Basque		–	**Pisuak eta Neurriak**
17	Galician		Rom	*Pesas e Medidas*
18	Portuguese		Rom	**Pesos e Medidas**
19	Spanish		Rom	Pesas y Medidas
20	Catalan		Rom	Pesos i Mesures
21	Occitan		Rom	Peses e Mesuras
22	Provençal		Rom	Pes e Mesuri
23	Swiss German	2	D-DE	Mass u Gwicht
24	Romansh	4	Rom	Peisas e Mesiras
25	Tessin	2	D-IT	Pes e Misür
26	Austrian German	2	D-DE	*Moss und Gwicht*
27	Friulian		Rom	*Pes e Misures*
28	Italian		Rom	Pesi e Misure
29	Latin		Rom	Pondus et Mensura
30	Corsican	2	D-IT	*Pesi e Misure*

31	Sardinian		Rom	Pesi e Misure
32	Sicilian	2	D-IT	Pesi e Misure
33	Maltese		Sem	Wiżen u Qies
34	Greek		–	Μέτρα και Σταθμά
35	Turkish		Turk	Ölçüler ve Ağırlık
36	Gagauz	5	Turk	?
37	Romanian		Rom	Măsuri şi Greutăţi
38	Bulgarian		Slav	Мерки и Теглилки
39	Macedonian		Slav	Мерка и Тежина
40	Albanian		–	Peshat dhe Matjet
41	Serbian		Slav	Мера и Тежина
42	Romany	6	–	Crdini thaj Pharipe
43	Croatian		Slav	Mjera i Težina
44	Slovene		Slav	*Mere in Teža*
45	Hungarian		Finn	Súly és Mérték
46	Slovak		Slav	*Miery a Váhy*
47	Czech		Slav	Míry a Váhy
48	Sorbian		Slav	*Měra a Waha*
49	Kashubian		Slav	?
50	Polish		Slav	**Miary i Wagi**
51	Yiddish		Germ	מאס און געווייכט
52	Ukrainian		Slav	**Міри та Ваги**
53	Belorussian		Slav	Мяры ды Ваги
54	Russian		Slav	Мера и Вес
55	Mordvin		Finn	?
56	Chuvash		Turk	?
57	Cheremis	7	Finn	?
58	Tatar		Turk	Үлчəм həм Авырлык
59	Kazakh		Turk	Өлшой жэне Мөлшөр
60	Kirgiz	*As*	Turk	*Өлшоу жана Ауырлық*

61	Bashkir		Turk	*Часәм һәм Ауырләк*
62	Udmurt		Finn	?
63	Zyryan	8	Finn	?
64	Yurak	9	–	?
65	Karelian		Finn	Miärät ja Painot
66	Finnish		Finn	*Mitat ja Painot*
67	Estonian		Finn	Mõõdud ja Kaalud
68	Latvian		Balt	Mērs un Svars
69	Lithuanian		Balt	*Masė ir Svoris*
70	Danish	1	Germ	Maal og Vægt
71	Norwegian		Germ	*Mål og Vekt*
72	Swedish		Germ	Mått och Vikt
73	Lappish/Saamic		Finn	Mihttu ja Deaddu
74	Faroese		Germ	Mát og Vekt
75	Icelandic		Germ	Mál og Vog
76	Eskimo/Innuit	*Am*	–	Ugtorpä okimailutaks-lo
77	Hebrew	*As*	Sem	מדידה ומשקל
78	Persian	*As*	–	وأن و أذراه
79	Arabic	*Af*	Sem	الاوذان و القيأسأت
80	Swahili	*Af*	–	Uzani
81	Afrikaans	*Af*	Germ	Mate en Gewichte
82	Thai/Siamese	*As*	–	ชั่งตวงวัด
83	Vietnamese	*As*	–	Cân vā đo
84	Korean	*As*	–	법 정 계 량
85	Taiwanese	*As*	–	[illegible]
86	Chinese	10 *As*	–	度量衡 (du liang heng)
87	Japanese	*As*	–	度量衡 (do ryo ko)

As can be seen, there are nine fields with a question mark. In these cases the author did not obtain the term in that language, especially those used in parts of the Russian Federation. It may be that readers can help him to complete the list. The same thing may happen with the correct spelling of the term in the different languages, some misspellings are possible. ■

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Contact Information

Dr. Detlev Mencke
(Formerly PTB Braunschweig)

Private address:
Mierendorffweg 2
D-38116 Braunschweig
Germany
Phone and fax: +49 531 511 802

E-mail address of his deputy at the PTB:
michael.rinker@ptb.de

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Certificates registered 2004.02–2004.04

Up to date information (including B 3): www.oiml.org

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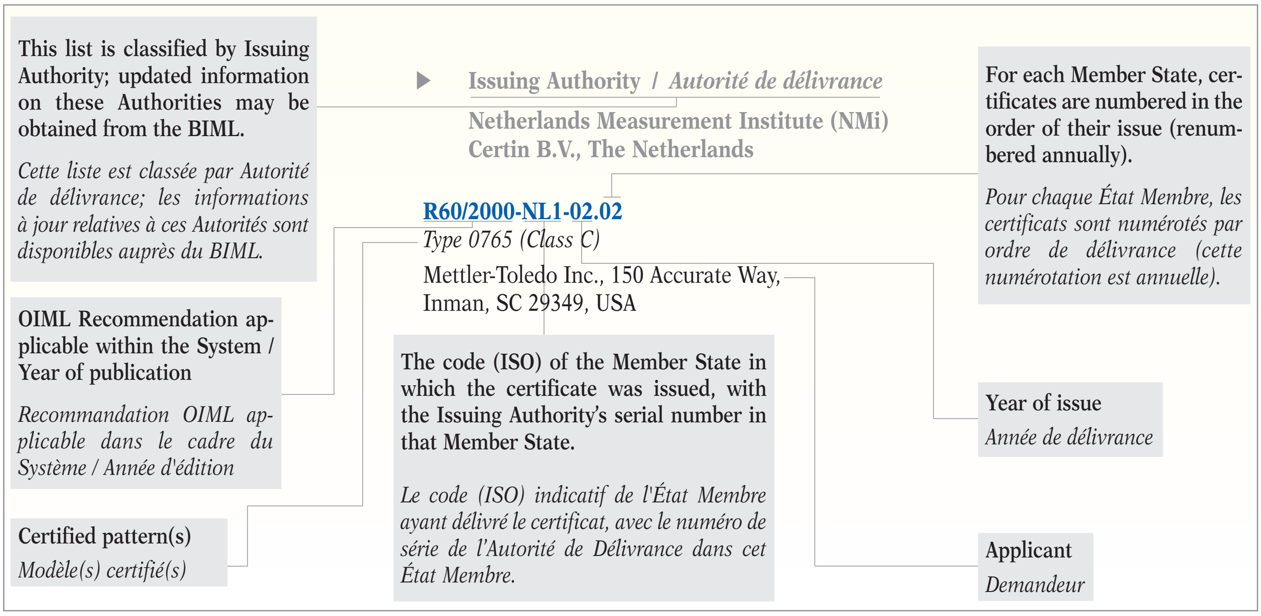

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Certificats enregistrés 2004.02–2004.04

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INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

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

R 51 (1996)

▶ Issuing Authority / *Autorité de délivrance*

Laboratoire National d'Essais
Service Certification et Conformité Technique
Certification Instruments de Mesure, France

R051/1996-FR2-2003.01
ETA for accuracy class Y(a)

Mettler-Toledo (Albstadt) GmbH, Unter dem Malesfelden 34, D-72458 Albstadt, Germany

▶ Issuing Authority / *Autorité de délivrance*

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

R051/1996-NL1-2004.01
AW-3600 … - … for class Y(a)

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

R051/1996-NL1-2004.02
SV series for accuracy class X(1)

Anritsu Industrial Solutions Co. Ltd., 1800 Onna Atsugi-shi, 243, Kanagawa-Prefecture, Japan

▶ Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R051/1996-DE1-1998.02 Rev. 1
Types HC... (Classes X(1)and Y(a))

Wipotec, Wägetechnik und Positioniersysteme GmbH, Adam-Hoffmann-Straße 26, D-67657 Kaiserslautern, Germany

R051/1996-DE1-2003.13
BW B… for accuracy class Y(a)

PESA Waagen AG, Witzbergstr. 25, CH-8330 Pfäffikon, Switzerland

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*

National Weights and Measures Laboratory (NWML), United Kingdom

R060/2000-GB1-2004.01
AW410/xxxxxCH (classes C3 and C2.5)

Applied Weighing International Ltd., Unit 5, Southview Park, Caversham, Reading, Berks. RG4 5AF, United Kingdom

R060/2000-GB1-2003.01
ASC (Class C5 MR)

Revere Transducers Europe BV, Ramshoorn 7, P.O. Box 6909, NL-4802 HX Breda, The Netherlands

R060/2000-GB1-2003.02
AW500/0xxxxC (Class C3)

Applied Weighing International Ltd., Unit 5, Southview Park, Caversham, Reading, Berks. RG4 5AF, United Kingdom

▶ Issuing Authority / *Autorité de délivrance*

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

R060/2000-NL1-2004.01
SSC (Classes C and D)

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

R060/2000-NL1-2004.02 Rev. 1
1022 (Class C)

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

R060/2000-NL1-2004.03
614 (Class C)

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

R060/2000-NL1-2004.04
SK... (Class C)
Scaime S.A., Z.I. de Juvigny, B.P. 501,
F-74105 Annemasse Cedex, France

R060/2000-NL1-2004.05
SBK... (Class C)
Scaime S.A., Z.I. de Juvigny, B.P. 501,
F-74105 Annemasse Cedex, France

R060/2000-NL1-2004.06
CSI... (Class C)
Precia Molen, BP 106, F-07001 Privas Cedex, France

▶ Issuing Authority / *Autorité de délivrance*
Office Fédéral de Métrologie, Switzerland

R060/2000-CH1-2003.01
ED21/SO (Class C)
DIGI SENS AG, Freiburgstrasse 65, CH-3280 Murten, Switzerland

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

R060/2000-CN1-2003.06
YZ108 (Class C3)
Youngzon Transducer (Hangzhou) Co., Ltd., No. 1, Building Industry Garden, No. 75 Wenhua Rd., 310012 Hangzhou, China

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic gravimetric filling instruments
Doseuses pondérales à fonctionnement automatique

R 61 (1996)

▶ Issuing Authority / *Autorité de délivrance*
National Weights and Measures Laboratory (NWML), United Kingdom

R061/1996-GB1-2004.01
CCW-SE for accuracy class Ref X(1)
Ishida Co., Ltd., 44, Sanno-cho, Shogoin,
Sakyo-ku, 606-8392, Kyoto-city, Japan

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*
Korean Agency for Technology and Standards, MOCIE, Republic of Korea

R076/1992-KR1-2004.01
MX-300 (Class III)
Fanics, #780-1, Banyeo 1-dong, Haeundae-gu,
612-810 Busan, Korea (R.)

▶ Issuing Authority / *Autorité de délivrance*
National Standards Commission, Australia

R076/1992-AU1-2002.01 Rev. 1
PSC Model Magellan 8502 and 9502 (Class III)
PSC Inc., 959 Terry Street, 97402, Oregon, Eugene, Oregon, United States

▶ Issuing Authority / *Autorité de délivrance*

National Weights and Measures Laboratory (NWML), United Kingdom

R076/1992-GB1-2004.03
E1105 (Class III)
GEC Avery Berkel Limited, Foundry Lane, Smethwick, Warley, B66 2LP, West Midlands, United Kingdom

R076/1992-GB1-2004.05
1310 (Class III)
GEC Avery Berkel Limited, Foundry Lane, Smethwick, Warley, B66 2LP, West Midlands, United Kingdom

▶ Issuing Authority / *Autorité de délivrance*

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

R076/1992-NL1-2004.01
SM-800.. (Class III)
Teraoka Weigh-System PTE LTD, 4 Leng Kee Road, #06-01 SIS Building, 159088, Singapore

R076/1992-NL1-2004.02
AJ(H) (Classes I and II)
Shinko Denshi Co., Ltd, 3-9-11 Yushima, Bunkyo-ku, 113-0034 Tokyo, Japan

R076/1992-NL1-2004.03
DS-520… / DS-530… (Class III)
Teraoka Seiko Co., Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, 146-8580 Tokyo, Japan

R076/1992-NL1-2004.04
AM, FD110, FDP110, SA110, SAP110, GE, GEP, GL, ALC3,FD120, FG120, SA120 (Class III)
Excell Precision Co. Ltd., 6F, No. 127, Lane 235, Pao-Chiao Road, Hsin Tien, Taipei Hsien, Taiwan, Chinese Taipei

R076/1992-NL1-2004.05
GR, GRP, AC.., SBC.. and UBC.. series (Class III)
Excell Precision Co. Ltd., 6F, No. 127, Lane 235, Pao-Chiao Road, Hsin Tien, Taipei Hsien, Taiwan, Chinese Taipei

R076/1992-NL1-2004.06 Rev. 1
AP, SB510, SB710, TC-3, MTC-3, LTC-3, SB520, SB720, SB721, RLC, MRC-3, LRC-3 (Class III)
Excell Precision Co. Ltd., 6F, No. 127, Lane 235, Pao-Chiao Road, Hsin Tien, Taipei Hsien, Taiwan, Chinese Taipei

R076/1992-NL1-2004.07
MP49 (Class III)
Pitney Bowes Ltd, The Pinnacles, CM19 5BD, Harlow, Essex, United Kingdom

R076/1992-NL1-2004.08 Rev. 1
98211-A (Class III)
Mastercool, 2 Aspen Drive, NJ 07869-1103 Randolph, United States

▶ Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R076/1992-DE1-1998.04 Rev. 3
BD BH 110 (Class I), DT BH 210 (Class II) and DS BH 310, DT BH 310 (Class III)
Sartorius A.G., Postfach 32 43, D-37070 Göttingen, Germany

R076/1992-DE1-2000.09 Rev. 7
iso-TEST (Classes I, II, III and IIII)
Sartorius A.G., Weender Landstraße 94-108, D-37075 Göttingen, Germany

R076/1992-DE1-2002.02 Rev. 2
DX BO 300, DY BO 300 (Classes III and IIII)
Sartorius A.G., Weender Landstraße 94-108, D-37075 Göttingen, Germany

R076/1992-DE1-2004.01
SIWAREX FT… (Classes III and IIII)
Siemens AG, Östliche Rheinbrücken Straße 50, D-76187 Karlsruhe, Germany

▶ Issuing Authority / *Autorité de délivrance*

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

R076/1992-RU1-2003.04
Mercury 3 (Class III)
INCOTEX - S Ltd., 26, 16th Parkovaya, 105484 Moskow, Russian Federation

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Discontinuous totalizing automatic weighing instruments (Totalizing hopper weighers)
Instruments de pesage totalisateurs discontinus à fonctionnement automatique (Peseuses totalisatrices à trémie)

R 107 (1997)

▶ **Issuing Authority / *Autorité de délivrance***

Physikalisch-Technische Bundesanstalt (PTB), Germany

R107/1997-DE1-2003.01
Bulk 9 for accuracy class 0.2, 0.5, 1 or 2
Chronos Richardson GmbH, Reutherstr. 3,
D-53773 Hennef, Germany

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

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

R 117 (1995) + R 118 (1995)

▶ **Issuing Authority / *Autorité de délivrance***

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

R117/1995-NL1-2004.01
QUANTIUM-XXXt
Tokheim Europe B.V., Reaal 5C,
NL-2353 TK Leiderdorp, The Netherlands

Updated information on OIML certificates:

www.oiml.org

Assessment of OIML Activities

2003

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Assessment of OIML Activities 2003

1 OIML Member States and Corresponding Members

Member States:	60	(+2)
Corresponding Members:	49	(–2)
Total:	**109**	**(=)**

2 New and revised OIML Recommendations and Documents issued

New Recommendation issued:	1	R 134-1
Revised Recommendations issued:	2	R 49-1, R 84
Revised Basic Publication issued:	1	B 3 (ex. P 1)
Other Publications issued:	2	E 2, S 1

	2000	2001	2002	2003
Total number of Recommendations:	111	114	115	116
Total number of Documents:	26	27	27	27
Total number of other Vocabularies:	3	3	3	3
Total number of other Publications:	17	17	17	19

3 OIML Technical Committees and Subcommittees: Meetings and degree of participation of OIML Members

TC 12 (WG)	27–28 March 2003	Maastricht	15 P-Members present out of 23 + three O-Members
TC 3 & TC 3/SC 5 (MAA)	2–6 June 2003	Paris	CIML Members or representatives from 18 Member States
TC 8/SC 3	6–9 October 2003	Paris	17 P-Members present out of 26
TC 8/SC 4	6–9 October 2003	Paris	15 P-Members present out of 21 + two O-Members
TC 8/SC 5	9 October 2003	Brussels	10 P-Members present out of 23 + one O-Member
TC 8/SC 1	30–31 October 2003	Vienna	6 P-Members present out of 20 + one O-Member

4 Liaisons with other international and regional bodies

BIML representatives participated in the following meetings in 2003:

CIPM - ILAC - CIML	February	BIML	*Annual Joint Meeting*
JCGM	February & May	Sèvres	*WG2 Meeting*
WTO TBT Committee	March & July	Geneva	*Seminar and Committee Meeting*
WTO/OIML/IEC	April	Lima	*Seminar for Southern African Countries*
SADCMEL	April	Livingstone	*Committee Meeting*
WTO/OIML/IEC	May	Maputo	*Seminar for Southern African Countries*
WELMEC	May	Madrid	*Committee Meeting*
JCDCMAS	July	BIPM	*Joint Committee Meeting*
ILAC	September	Bratislava	*General Assembly*
ISO DEVCO	September	Buenos Aires	*Annual Meeting*
CGPM	October	Paris	*General Conference*
APLMF	November	Kyoto	*Committee Meeting*
UNIDO	December	Vienna	*Expert Group Meeting*

In addition, the CIML President, Vice-Presidents, Development Council Chairperson and certain CIML Members represented the OIML at meetings of:

APLMF - COOMET - EUROMET - ISO - SIM - WELMEC

Concerning various technical activities of ISO, IEC, CEN, CENELEC and the European Commission, OIML experts participated in meetings and/or reports were given for the following fields:

- Water meters
- Acoustic measurements
- Electromagnetic interference
- Draft European Directive on Measuring Instruments (MID)
- Electricity meters
- Vehicle exhaust gases

5 Degree of implementation of OIML Recommendations by OIML Members

An inquiry on the implementation of OIML Recommendations was made in 2000. In comparison with the previous inquiries made in 1992 and in 1996, the significant increase in the number of countries implementing individual Recommendations and in the degree of implementation ensured is represented in the histogram on the following page. Based on the inquiry, on additional information and on corrections received from Member States in 2001, the highest performing OIML Recommendations in 2001 were as in the table below.

R 76	Nonautomatic weighing instruments	*Implemented in 39 countries*
R 35	Material measures of length for general use	*Implemented in 33 countries*
R 111	Weights of classes E_1, E_2, F_1, F_2, M_1, M_2, M_3	*Implemented in 33 countries*
R 50	Continuous totalizing automatic weighing instruments	*Implemented in 29 countries*
R 31	Diaphragm gas meters	*Implemented in 29 countries*
R 117	Measuring systems for liquids other than water	*Implemented in 29 countries*
R 51	Automatic catchweighing instruments	*Implemented in 28 countries*

A new inquiry on the implementation of OIML Recommendations by Member States and Corresponding Members is being carried out in 2004.

6 Categories of measuring instruments covered by the OIML Certificate System

37 categories of measuring instruments are covered by the following OIML Recommendations:

R 16-1 & R 16-2	R 85	R 110	R 127
R 31	R 88	R 112	R 128
R 50	R 93	R 113	R 129
R 51	R 97	R 114	R 130
R 58	R 98	R 115	R 131
R 60	R 102	R 116	R 132
R 61	R 104	R 117/R 118	R 133
R 65	R 105	R 122	
R 76	R 106	R 123	
R 84	R 107	R 126	

Total number of Recommendations applicable within the Certificate System	1998	1999	2000	2001	2002	2003
	25	28	31	34	38	39
		+ 12 %	+ 11 %	+ 10 %	+ 12 %	+ 2.6 %

7 Cumulative number of registered OIML Certificates (as at the end of 2003)

Category:

Nonautomatic weighing instruments (R 76)	542	≈ 45.5 %
Load cells (R 60/1991 *Note: Certificates may no longer be issued*)	226	≈ 19.0 %
Load cells (R 60/2000)	152	≈ 12.8 %
Automatic catchweighing instruments (R 51)	97	≈ 8.1 %
Automatic gravimetric filling instruments (R 61)	49	≈ 4.1 %
Fuel dispensers for motor vehicles (R's 117/118)	44	≈ 3.7 %
Gas meters (R 31)	22	≈ 1.8 %
Automatic level gauges (R 85)	17	≈ 1.4 %
Automatic weighing instruments (R 107)	9	≈ 0.8 %
Continuous totalizing automatic weighing instruments (R 50)	10	≈ 0.8 %
Direct mass flow measurement systems (R 106)	9	≈ 0.8 %
Evidential breath analyzers (R 126)	1	≈ 0.1 %
Clinical electrical thermometers (R 115)	1	≈ 0.1 %
Multi-dimensional measuring instruments (R 129)	3	≈ 0.3 %
Cumulative total, as at the end of 2003	**1192**	

Cumulative number of registered OIML Certificates

1998	1999	2000	2001	2002	2003
452	582	736	879	1027	1192
	+ 29 %	+ 26 %	+ 19 %	+ 17 %	+ 16 %

316 manufacturers and applicants of measuring instruments from 34 countries have been granted OIML Certificates

8 Degree of acceptance of OIML Certificates by OIML Members

The latest inquiry on the acceptance of OIML Certificates by OIML Members was carried out by the BIML in 2000.

The next inquiry on the acceptance of OIML Certificates is being carried out in 2004 among Issuing Authorities, Member States, Corresponding Members and Manufacturers.

9 Distribution of the OIML Bulletin and revenue from the sale of OIML Publications

	2000	2001	2002	2003
Average number of **Bulletins** distributed quarterly	1100	1050	1038	1018
		– 4.5 %	– 1.1 %	– 1.9 %
... of which **Bulletin** subscribers	156	153	161	144
		– 1.9 %	+ 5.2 %	– 1.1 %
Sales of **Publications** (EUR)	32 626*	38 021*	41 500	25 130
		+ 16.5 %	+ 9.2 %	– 39.4 %

* *Figures for 2000 and 2001 have been converted into Euros*

10 Connections to and development of the OIML web site (www.oiml.org)

- 1998: 500 connections
- 1999: 1 000 connections
- 2000: 2 500 connections
- 2001: 2 500 connections
- 2002: 6 500 distinct visits / 34 500 pages viewed / 110 000 hits
- 2003: 3 725 distinct visits / 32 982 pages viewed / 124 000 hits

Note: All figures are per month

11 Activities in support of development

Main activities:

- OIML Development Council Meeting (1 November 2003, Kyoto) with 65 participants;
- Meeting of the OIML Development Council Task Group (4 November 2003,Kyoto);
- Development Council Task Group worked throughout year by electronic means;
- Follow-up of the existing work programs of the Development Council Working Groups;
- Began establishment of Permanent Working Group for Developing Countries;
- Participation in the Joint Committee on coordination of assistance to Developing Countries in Metrology, Accreditation and Standardization (JCDCMAS):
  - Meetings held in April 2003 (Vienna) and July 2003 (Sèvres);
  - Expert Group Meeting held in conjunction with UNIDO General Conference in December 2003 (Vienna);
  - Completion of WTO instigated database on technical assistance needs;
- Contacts with international organisations (WTO TBT Committee, ISO DEVCO, UNIDO, UN/ECE, etc.), and regional metrology and legal metrology organisations;
- Contacts with the bodies in a number of countries which provide assistance to developing countries (PTB Germany, NWML UK, SdM France, etc.);
- Ongoing participation in a PTB/UNIDO/OIML project in West Africa concerning the development of metrology in the region.

BIML, June 2004

RLMO MEETING

SADCMEL Update

Brian Beard
Technical Advisor: Legal Metrology
South African Bureau of Standards

Over the past year, the Southern African Development Community Cooperation in Legal Metrology (SADCMEL) has held two general meetings, a meeting of TC1 (which deals with the sale of goods) and a seminar on tolerances for the sale of goods. This report briefly covers these events.

14th SADCMEL Meeting

The 14th SADCMEL meeting was held in Lilongwe, Malawi on 24 November 2003. It was attended by 23 delegates from 12 member countries. The following is a summary of main agenda items.

Stuart Carstens, the South African CIML Member, gave feedback on the 2003 CIML Meeting, OIML Development Council meeting and the APLMF meeting in Kyoto that he attended as an observer.

Country reports revealed that several member countries are in the process of upgrading or implementing new legislation.

Reports on activities were received from TC1 (Sale of goods), TC2 (Instruments) and TC4 (Training). Under an agenda item in the TC2 segment amendments to maximum permissible errors (MPEs) in the SADCMEL requirements for non self indicating counter scales were discussed and agreement reached. The MPEs are now aligned with requirements in OIML R 76-1 for scales with the largest permissible verification scale intervals.

It was agreed to review the objectives of SADCMEL and update them as necessary. Several proposals were discussed and it was decided to circulate a new set of objectives for comment and later adoption.

OIML participation in the Joint Committee for Developing Countries in Metrology, Accreditation and Standards (JCDCMAS) was discussed and members were requested to complete a questionnaire giving country details for forwarding to the BIML.

Seminar on tolerances for the sale of goods

One of the objectives of SADCMEL is to harmonize the requirements of technical regulations within the Region and bring them in line with the most common international requirements. A harmonized document covering requirements for labeling of goods was adopted in 2003 and the next step was to prepare a draft document on tolerances for the sale of goods based on the latest version of OIML R 87 "Quantity of product in prepackages".

A survey of additional local requirements was conducted and the resultant draft also contains requirements for accuracy of measurement at the time of sale, requirements for random quantity prepackages, special tolerances for certain types of goods and a few other additions to the requirements of OIML R 87.

On 25 and 26 November 2003 a seminar to evaluate the requirements of OIML R 87 and the new SADCMEL draft document was held in Lilongwe, Malawi. The seminar was partially funded by the PTB (Germany) which also provided a consultant, Mr. Klaus Helmboldt of Bremen, to benchmark our document and give pointers for improvement.

The objective of the seminar was for SADCMEL decision makers to obtain an EU interpretation and explanation of the application of some of the requirements in the new OIML R 87 and evaluate the SADCMEL document to ensure that it meets the needs of the Region and is compatible with international requirements.

The seminar was attended by 21 delegates representing 12 SADC member States and one SADCMEL corresponding member. After an explanation of the seminar objectives the first day and a half was taken up with evaluating the requirements of OIML R 87 and obtaining input from Mr. Helmboldt as to how various requirements were applied in Germany. At strategic times during the discussions Mr. Helmboldt presented informative lectures entitled:

- Overview of OIML Recommendations R 79 and R 87;
- Harmonization of requirements for prepackages; and
- Basic statistics for sampling of prepackages.

The outcome of this session was that SADCMEL members received a thorough background to the requirements of OIML R 87 and were equipped to evaluate and deliberate on the SADCMEL version.

The rest of the seminar was taken up by discussions on the SADCMEL document. Additional requirements were explained and important agreements reached on the following issues:

- Clarity of definitions;
- Application of tolerances to desiccating commodities for which a list of applicable products was drawn up;

- New tolerance for solids sold by cubic measure e.g. compost;
- Application of requirements for products required to be marked with their drained mass and the addition of mixtures of edible oil and water to the list of liquid mediums to which drained mass requirements apply;
- General test methods; and
- Equipment used for inspecting frozen products.

At the end of the seminar agreement was reached on the SADCMEL document and there were no outstanding issues requiring further investigation. It was agreed that the document should be discussed with all role players (industry and consumers) to obtain comment and input on the practical application of requirements. Feedback was to be discussed at the SADCMEL TC1 meeting in April 2004.

SADCMEL TC1 meeting, April 2004

This meeting was held at the time of the annual SADC SQAM (Standards, Quality Assurance, Accreditation and Metrology) meetings in Port Louis, Mauritius on 19 April 2004. It was attended by 17 delegates from 11 member countries and Mr. J-F. Magaña of the BIML. The main agenda item was the discussion of feedback from industry and other role players on the draft SADCMEL document dealing with tolerances for the sale of goods. Issues resulting in amendment (in some cases to OIML R 87 wording) included:

- Change to the definition of "Inadequate prepackage" for clarity;
- Addition of a definition for "Non-automatic instrument";
- Provision for the use of automatic instruments as check instruments;
- Provision for bottles of wine and other alcoholic beverages with non-moisture retaining enclosures to comply with requirements for at least 12 months after the date of packaging;
- Provision for special maximum permissible errors for fresh fruit and vegetables, permanent and dissolved gasses and seed sold by number;
- Provision for the use of approved templates associated with measuring container bottles for inspection of packages under certain conditions; and
- Standardization of the sieve sizes and test methods for the inspection of frozen or glazed products. These are now in line with CODEX requirements.

At the end of the meeting it was agreed that the amendments would be discussed with role players and any feedback discussed at the 16th SADCMEL meeting in November 2004.

15th SADCMEL meeting

The 15th SADCMEL meeting took place on 22 April 2004 in Port Louis, Mauritius. It was attended by 34 delegates including invited guests from the PTB, the BIML and the metrology authority of The Reunion. Below is a summary of key agenda items.

Members were invited to highlight aspects from country reports and several countries mentioned expansion or restructuring programs. This is an indication that legal metrology is receiving higher levels of governmental recognition and support.

Jean-Francois Magaña, BIML Director, presented an overview of important OIML activities. These included:

- Progress with the Mutual Acceptance Arrangement (MAA), which will ensure confidence in type evaluation test reports issued by participating members. Rules for participation, proof of competence, Declarations of Mutual Confidence, Committee on Participation Review and fees were all discussed;
- Assistance to developing countries: information was given on participation in JCDCMAS, the setting up of a permanent Working Group on Developing Countries and the forum on developing countries to be held on 25 October 2004 on the occasion of the OIML meetings;
- Publication of OIML Information Letters;
- Update on the status of amendments to various OIML Documents;
- Proposals to offer OIML publications, except documents published jointly with other organizations, free of charge; and
- Improvements to the OIML web site.

Dr. K Stoll-Malke of the PTB gave an overview of PTB support for SADCMEL and the latest funding made available by the German Government. Indicators and outcomes agreed upon as a condition of the funding were discussed and the necessity of achieving these was stressed. South Africa will provide a representative for the project management committee to ensure the smooth progress of the project and provision of reports on implementation and successes.

The Regional Coordinator reported on progress with a broader funding initiative being negotiated by the SADC Secretariat with the EU for capacity building in the Standards, Quality Assurance, Accreditation and

Metrology arena. This should also be in place within the coming year and will assist in broadening the scope of legal metrology in most member countries.

Reports on activities were received from TC1, TC2 and TC4 and general matters were discussed. TC2 was requested to evaluate available OIML Recommendations on simple measures used in trade, including liquor measuring devices, and if not suitable for adoption, to prepare a draft SADCMEL document covering these instruments. The question of software evaluation was raised as a concern because approval authorities in the Region are approving more and more instruments with sophisticated software but lack the means to check it. Members were advised to consult and accept evaluations conducted in pursuance of OIML or other international approval certificates for these instruments. If there was any doubt they should contact the approving authority for advice. Mr. Magaña informed members that this matter was being addressed by the OIML and eventually there could be several documents dealing with software and its evaluation.

Mr. Francis Karani of Zimbabwe was elected as SADCMEL chairperson for a two year term of office. The TC chairpersons were confirmed for the next two years. They are Brian Beard of South Africa for TC1, Kimon Zulu of Zambia for TC2 and TC3 (Rules and Procedure) and Peter Molefe of Botswana for TC4.

The next SADCMEL meeting will be held in Namibia during November 2004.

Summary

All SADCMEL activities were successful and contributed to meeting the objectives of the organization. Capacity building in most of the least developed countries is progressing well and will receive a boost with the additional funding committed over the next few years. On behalf of the Chairperson and SADCMEL members I would like to express our sincere appreciation to the PTB and the OIML for all their support and assistance received over the past year. ■

RLMO MEETING

COOMET TC2 *Legal Metrology*

5th Meeting

Bratislava, 31 March–1 April 2004

HARTMUT APEL
Presidential Sector, PTB, Germany

COOMET is the Regional Organization for the European-Asian Cooperation of National Metrological Institutions and comprises 14 Member Countries.

The fifth international meeting of COOMET TC 2 *Legal Metrology* was held at the Slovak Institute of Metrology (SMU) in Bratislava from 31 March to 1 April 2004, organized by SMU staff under the leadership of its Director, Mr. M. Bily. 14 delegates attended, representing the following COOMET Member Countries: Belarus, Germany, Moldova, Russia and Slovakia.

The session was led by the Chairman of TC 2, Mr. Hartmut Apel (PTB, Germany), who had also invited TC 2/SC 2 *Software Requirements and Testing* to attend, headed by Mr. M. Shabanov (BelGIM, Belarus). The aim of this Subcommittee is to coordinate national policy and testing procedures on software by the exchange of documentation and experience with a view to promoting the development of software requirements and test procedures. The Working Group met for the second time on the same occasion as TC 2, partly in a parallel session.

COOMET, as a regional organization for cooperation in scientific and industrial metrology, is traditionally concerned mainly with intercomparisons of measurement standards. However, in recent years legal metrology and (inter-)related issues such as quality management systems and accreditation are becoming increasingly important. This is mainly due to world-wide efforts to diminish technical barriers, thus facilitating international trade. Two major subjects related to this topic were therefore introduced by the Chairman of TC 2 in separate presentations and followed by lively discussions:

- "The OIML Mutual Acceptance Arrangement (MAA) - a model for COOMET cooperation?"; and
- "The European 'Measuring Instruments Directive' (MID) and its national implementation".

In view of the fact that the MID was adopted on March 31 2004 by the European Parliament and the Commission, the consequences of maintaining an appropriate level of consumer protection have been widely discussed. The Deputy Chair of TC 2, Mr. R. Hahnewald, gave a presentation on "Market Surveillance in the framework of the MID" and shared the experience of the German Verification Offices after the implementation of the Non-Automatic Weighing Instruments (NAWI) Directive, this being the first harmonized European Directive for measurement devices drawn up according to the European policy of a single market and based on the New and the Global Approach. The results of that market surveillance activity have given good reasons for concern with regard to this type of weighing instruments and their conformity to the minimum technical requirements as stipulated by the NAWI Directive.

Altogether, TC 2 identified ten specific projects in progress or in the pipeline, of which the two below are of particular importance and whose scope is beyond that of TC 2 alone.

i) Development of a Recommendation on Software testing for measuring instruments

Dr. U. Grottker (PTB) gave a presentation on WELMEC Guide 7.1 (MID Software Guide) and its level of implementation in Germany. The PTB is applying this Guide for measuring instruments covered by the MID, but in many cases the level of severeness of software testing has not yet been defined according to the category of measurement device. Besides, the specificities of EU legislation do not prescribe metrological control for the following:

- Measuring (software) applications which generate results for the purpose of conformity assessment in certification and other conformity assessment activity; and
- PC-based energy consumption billing systems.

The participants of TC 2/SC 2 confirmed that the MID is about to be introduced into their metrological legislation, which will inevitably require the establishment of well defined software requirements and testing procedures in almost all COOMET Member Countries. TC 2/SC 2 members agreed to exchange information regarding the registration of "measuring" software along with the measuring devices for which they are designated or special measuring software applications.

The priorities for future TC 2/SC 2 work were set and further steps were discussed on facilitating measurement software handling:

- To encourage identification of software used in applications covered by legal metrology at national level;

- To specify a minimum set of features required to be met by such software at national level, taking into account the MID Software Guide and the COOMET Recommendation; and
- To establish a legal registration mechanism for such software at national level.

The TC 2/SC 2 Recommendations are to be presented at the 14th COOMET Committee Meeting for consideration and approval.

ii) Liaisons with the OIML, Regional Organizations and National Metrology Institutes

There is growing awareness that national metrology should develop within the international framework of regional organizations as well as intensifying bilateral cooperation. Within this context the Russian delegation proposed a Project to be taken up in the next Work Program:

Analyze cooperation projects within the framework of international and regional organizations for the preparation of proposals for cooperation and joint work with COOMET in the field of legal metrology.

COOMET Members, for example, being at the same time participants in APLMF and WELMEC activities, should exchange results obtained and their respective experience thus avoiding duplicate efforts.

In this sense the implementation of the OIML MAA will be closely followed in order to draw conclusions in due course on its effectiveness and suitability to be possibly also applied for COOMET Member Countries.

The Legal Metrology TC agreed on their newly elaborated Draft "Regulations" and their procedures of work with the intention of presenting them for approval at the 14th COOMET Committee Meeting in Albena, Bulgaria, in May, 2004.

There was general consensus to meet again in 2005. ■

The OIML is pleased to welcome the following new

CIML Members

Rep. Korea

Mr. Yoo Tae JUN

Vietnam

Mr. Pham Ngoc Tran

Corresponding Member

Rwanda

OIML Meetings

15–16 September 2004 - Braunschweig, Germany
(Exact venue to be confirmed later)
TC 3/SC 4 Application of statistical methods

5 October 2004 - Paris, France
(Exact venue to be confirmed later)
TC 8/SC 5 Water meters

11 October 2004 - Dordrecht, The Netherlands
(Exact venue to be confirmed later)
TC 8/SC 8 Gas meters

25–29 October 2004 - Berlin, Germany
Development Council Meeting
39th CIML Meeting
12th International Conference on Legal Metrology

2–3 December 2004 - Vienna
TC 8/SC 1 Static volume measurement

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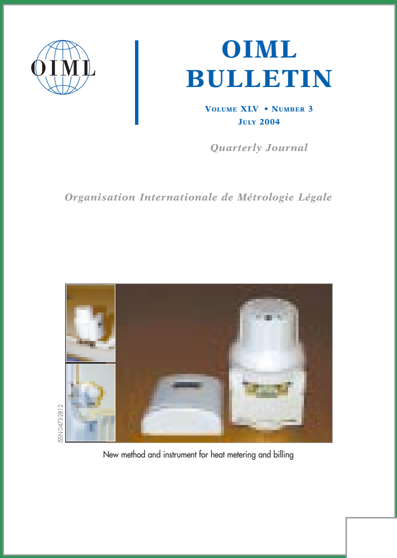
Committee Drafts

Received by the BIML, 2004.02 – 2004.04

Protein measuring instruments for cereal grain (Outline of the Recommendation)	E	WD	TC 17/SC 8	AU
Revision R 117	E	3 CD	TC 8/SC 3 & TC 8/SC 4	UK



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