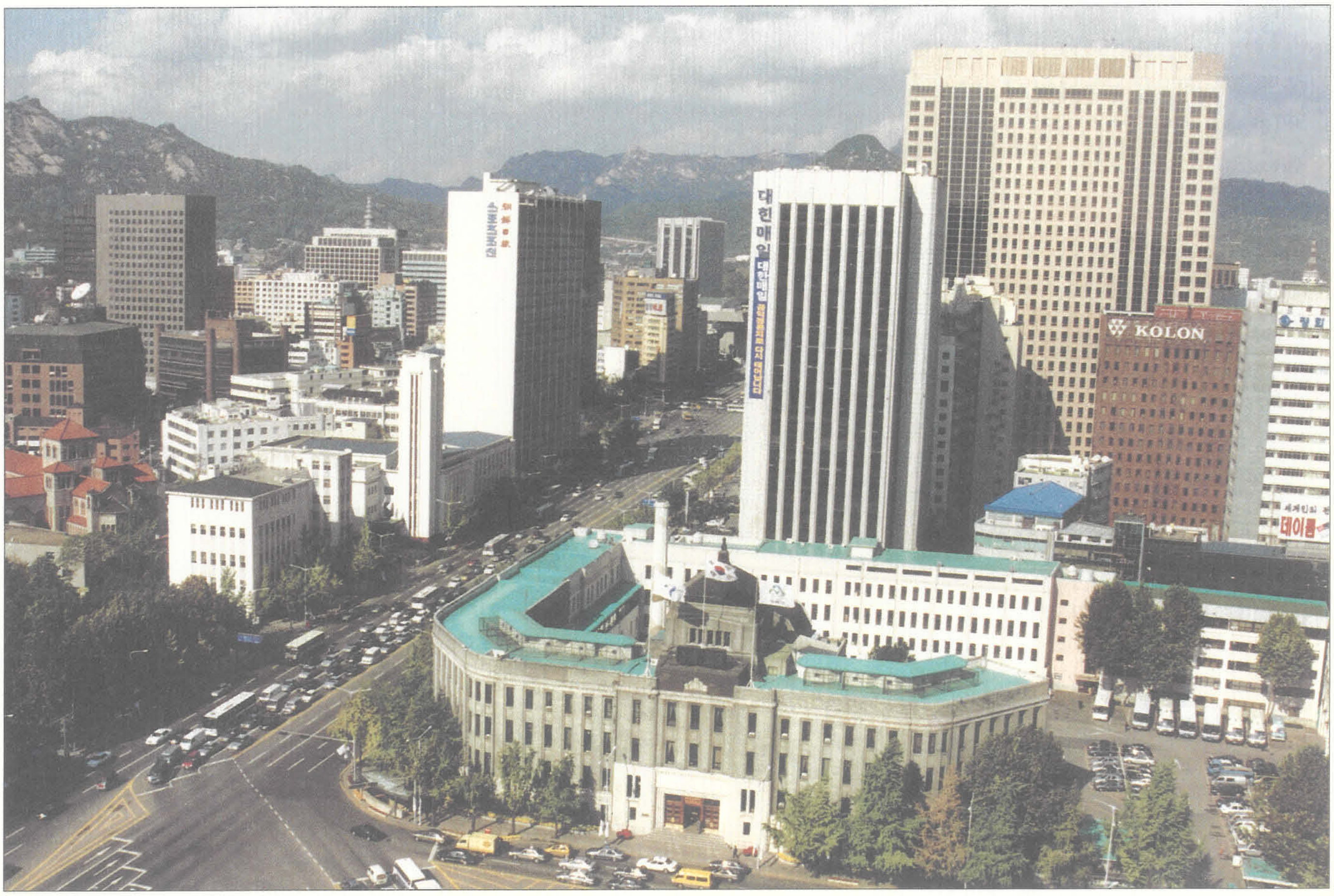
OIML BULLETIN

VOLUME XL • NUMBER 1 • JANUARY 1999

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

QUARTERLY JOURNAL



ISSN 0473-2812

The Republic of Korea hosts the 33rd CIML Meeting in Seoul

OIML BULLETIN
VOLUME XL • NUMBER 1
JANUARY 1999

THE OIML BULLETIN IS THE QUARTERLY JOURNAL OF THE ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE.

The Organisation Internationale de Métrologie Légale (OIML), established 12 October 1955, is an intergovernmental organization whose principal aim is to harmonize the regulations and metrological controls applied by the national metrology services of its Members.

OIML SECRETARIAT

BUREAU INTERNATIONAL DE MÉTROLOGIE LÉGALE (BIML)

11 RUE TURGOT – 75009 PARIS – FRANCE

TEL: 33 (0)1 4878 1282 / 4285 2711
FAX: 33 (0)1 4282 1727
E-MAIL: biml@oiml.org
INTERNET: http://www.oiml.org

1999 SUBSCRIPTION RATES
EUROPE: 400 FRF
OUTSIDE EUROPE: 450 FRF

ISSN 0473-2812
DEPOT LEGAL NO 9306
PRINTED IN FRANCE
GRANDE IMPRIMERIE DE TROYES
130, RUE GÉNÉRAL DE GAULLE
10000 TROYES

OIML

MEMBER STATES

Algeria
Australia
Austria
Belarus
Belgium
Brazil
Bulgaria
Cameroon
Canada
P. Rep. of China
Cuba
Cyprus
Czech Republic
Denmark
Egypt
Ethiopia
Finland
France
Germany
Greece
Hungary
India
Indonesia
Islamic Republic of Iran
Ireland
Israel
Italy
Japan
Kazakhstan
Kenya
Dem. P. Rep. of Korea
Rep. of Korea
Monaco
Morocco
Netherlands
Norway
Pakistan
Poland
Portugal
Romania
Russian Federation
Saudi Arabia
Slovakia
Slovenia
South Africa
Spain
Sri Lanka
Sweden
Switzerland
Tanzania
The Former Yugoslave Republic of Macedonia
Tunisia
United Kingdom
United States of America
Yugoslavia
Zambia

CORRESPONDING MEMBERS

Albania
Argentina
Bahrain
Bangladesh
Barbados
Bosnia and Herzegovina
Botswana
Colombia
Costa Rica
Croatia
Ecuador
Estonia
Fiji
Guatemala
Hong Kong, China
Iceland
Jordan
Kuwait
Latvia
Lithuania
Luxemburg
Madagascar
Malawi
Malaysia
Mauritius
Mexico
Moldova
Mongolia
Mozambique
Nepal
New Zealand
Oman
Panama
Papua New Guinea
Peru
Philippines
Seychelles
Singapore
Syria
Chinese Taipei
Thailand
Trinidad and Tobago
Turkey
Ukraine
Uruguay
Vietnam

OIML BULLETIN

VOLUME XL • NUMBER 1 • JANUARY 1999

technique

evolutions

update

33RD CIML MEETING AND OIML DEVELOPMENT COUNCIL MEETING, SEOUL

SEE ACCOUNT, PAGES 33–47

OIML BULLETIN

Volume XL • Numéro 1 • janvier 1999

technique

évolutions

informations

OIML Editorial

Building future strategy on past success

A year ago in the Editorial of the January 1998 Bulletin, we wrote that the coming year would represent a decisive turning point in the OIML's life, marked by positive and promising events. Looking back with hindsight on those reflections, where do we stand a year later? Have these hopes been transformed into concrete results? What is the real situation of our Organization at the outset of 1999?

■ The *Birkeland Study* is complete. After some eighteen months of thought and contacts world-wide, our Immediate Past President presented the results of his work and his recommendations to the CIML during its meeting in Seoul; a full account is published in this issue.

So now the Study is in its final state, thus marking the end of phase one, and phase two is about to start: i.e. to urgently bring these recommendations (and the comments raised by CIML Members during extensive discussions in Seoul) together into a concrete project with objectives to be reached over a pre-determined time period – not forgetting the means needed to achieve this. Other elements external to the OIML must also be taken into consideration, especially the report by the *Comité International des Poids et Mesures* on the national and international needs of metrology and the role of the BIPM.

■ The International Seminar on *The Role of Metrology in Economic and Social Development* organized in Braunschweig by the BIPM, IMEKO, OIML and the PTB (see account in the October 1998 Bulletin) more than lived up to expectations. The variety of subjects, the quality of the lectures, the wide representation of international and regional organizations and of course the excellent organization by our German hosts were the ingredients that led to the outstanding success of the event.

The conclusions have given rise to ongoing study and food for thought for future development. Only one element was perhaps lacking – wider representation of key "political" figures; many countries were represented by metrologists, who are already convinced of the necessity for metrology. This event will certainly not be the only one of its kind, and a follow-up event is already being tentatively planned.

■ Cooperation between OIML and a large number of international and regional organizations has developed considerably. Two particular examples can be given:

- OIML Recommendation R 99 on *Instruments for measuring vehicle exhaust emissions* is in the process of becoming an ISO Standard;
- OIML has been granted Observer Status within the WTO Technical Barriers to Trade Committee and has participated in all its meetings, particularly a recent information session (19 November 1998) during which those bodies which produce international standards (ISO, IEC, ITU, Codex Alimentarius, OIML, etc.) explained their objectives, work methods, liaisons, etc. and proved that they satisfy the requirements of the *Code of good practice for the preparation, adoption and application of standards*.

■ In parallel to the above-mentioned increase in liaisons, the global audience of the OIML has increased with the accession of new Members, which has more than offset the loss of three Corresponding Members in 1998.

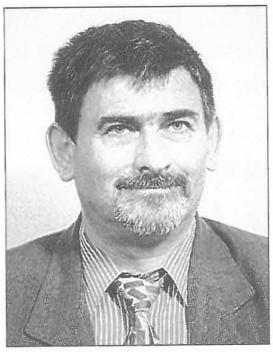
So the hopes raised a year ago have largely been fulfilled. There are, however, several elements that are casting a shadow over the future.

The most important of these is doubtless the decrease in human resources that the OIML has at its disposal. Under the combined effect of budgetary constraints, deregulation, an increase in regional activities and, for certain countries, recent political and/or economic changes, it is undeniable that the number of experts able to participate in OIML technical work has considerably dropped. This will cause us to have to make drastic choices in establishing priorities and in eliminating work that does not directly offer concrete advantages to the majority of OIML Member States. This could also lead the OIML to increasingly call on the resources of other international organizations which have the know-how that legal metrology needs.

Who knows, the positive outcome of this problem may perhaps be that OIML activities will become more directional and more highly specialized.

And so it is still with much optimism for the coming year that we wish all our readers a very happy New Year! ■

BIML



UNCERTAINTY

Handling correlated quantities in metrology

E. GÁTI, Head of Software Testing Section, OMH, Budapest, Hungary

Abstract

Some covariances arising in metrology can only be determined by their measurement, while others can be simply calculated. This paper illustrates some basic metrological applications, in the case where the covariances are simply calculable.

1 Introduction

International documents on measurement uncertainty (for example the GUM [1]) propose to give uncertainties in the form of one or two digits. This means that even the measurement uncertainty has an "accuracy", and it is necessary to express it to the highest possible accuracy level. In the author's opinion the measurement uncertainty is given accurately when it is a good estimation of the magnitude of the existing measurement error, the value of which is usually unknown. However this estimation, of course, cannot be *purely statistical,* because it may contain several subjective elements. Nowadays, many experts dispute this idea; in their opinion the measurement uncertainty is not the estimation of an existing quantity, but rather a purely subjective category that expresses the doubt of the individual carrying out the measurement as to its accuracy. As readers will note, this paper could only be written on the basis of the first theory.

However, the measurement uncertainty must not be given as accurately as a measurement result itself; it is useful to take all the components into consideration that contribute to the measurement uncertainty to a significant degree. One of these components is the *covariance*.

2 Definition of covariance and correlation coefficient

The probability theory defines the covariance of the random variable X with expectation μ_x and the random variable Y with expectation μ_y as the *expectation* of the product of their "errors":

$$\mathrm{cov}(X,Y) \equiv \langle (X - \mu_x)\,(Y - \mu_y) \rangle \equiv \langle \Delta X \Delta Y \rangle$$

where ΔX and ΔY are the errors for X and Y respectively.

The *theoretical* quantity defined this way is one of possible measures of the mutual dependence of the two quantities X and Y. When the value of the covariance equals zero, these two quantities are *uncorrelated,* and when it does not equal zero, they are *correlated.* If the random variables X and Y are *independent* in the statistical sense, then because of:

$$\mathrm{cov}(X,Y) \equiv \langle (X - \mu_x)\,(Y - \mu_y) \rangle \equiv$$

$$\equiv \langle X - \mu_x \rangle \langle Y - \mu_y \rangle \equiv 0{*}0 \equiv 0$$

they are uncorrelated at the same time. If X and Y are not dimensionless quantities, the unit of their covariance is the product of the units of X and Y. Instead of covariance, the use of a dimensionless correlation coefficient is often more comfortable, which is another measure of the degree of dependence of the two quantities:

$$R(X,Y) \equiv \frac{\mathrm{cov}(X,Y)}{\sigma_x \sigma_y}$$

where $\sigma_x \equiv +\sqrt{\langle (X - \mu_x)^2 \rangle}$ and $\sigma_Y \equiv +\sqrt{\langle (Y - \mu_Y)^2 \rangle}$

are the theoretical standard deviations.

The possible values of the correlation coefficient are between – 1 and + 1.

When evaluating a measurement, the previous *theoretical quantities* are usually substituted by their *estimations*. The usual designations for the estimations are:

$\mu_x \approx x$, $\sigma_x^2 \approx s^2(x)$ or $u^2(x)$, $\mathrm{cov}(X,Y) \approx u(x,y)$ and $R(X,Y) \approx r(x,y)$.

Later in this paper the estimations of the theoretical quantities appear throughout, but for simplicity the names of the theoretical quantities are used for their estimations. For instance, the term variance is used for the denomination of the estimation of the variance.

The measurands are given together with their uncertainties in the form of $\{x,u(x)\}$. Here x denotes the estimation of the expectation μ_x (or of the true value τ_x) of quantity X, and the standard deviation $u(x)$ denotes the estimation of σ_X.

In some measurement situations the quantities concerned are supposed to be correlated but the quantification of their dependence is only possible by the *measurements of the covariances*. In the other cases, the covariances can be handled by simple mathematical means. Further, in this paper various calculable covariances are provided.

The idea of some examples and the way of designating $\{x,u(x)\}$ is taken from Dr. Wolfgang Wöger's lecture draft.

Calculating with covariances is a very simple operation which contains several identical elements; in this paper the author has tried to give not only the final results but also to present these common ideas.

3 Some applications of covariances in metrology

3.1 Derivation of measurement standards* by the measurement of differences

3.1.1 Derivation in one step by the measurement of differences

Let the aim be to derive a standard $\{m_1,u(m_1)\}$ (for example: mass) from the standard $\{m_0,u(m_0)\}$, measuring the difference $\{k_1,u(k_1)\}$ on the basis of the expression:

$$m_1 = m_0 + k_1 \tag{1}$$

From (1) the error $\Delta(m_1)$ is $\Delta(m_1) = \Delta(m_0) + \Delta(k_1)$. Assuming the independence of m_0 and k_1, the variance of m_1 is:

$$u^2(m_1) \approx \sigma^2(m_1) \equiv \langle\Delta^2(m_1)\rangle = \langle\Delta^2(m_0) + \Delta^2(k_1) + 2\Delta(m_0)\Delta(k_1)\rangle = \tag{2}$$
$$= \langle\Delta^2(m_0)\rangle + \langle\Delta^2(k_1)\rangle + 2\langle\Delta(m_0)\Delta(k_1)\rangle \approx u^2(m_0) + u^2(k_1) + 0 = u^2(m_0) + u^2(k_1)$$

* *Throughout this text, "standard" signifies "measurement standard".*

This is quite obvious, since it follows from the "law of propagation of (independent) errors". It might not be unexpected either that m_0 and m_1 are correlated. Their covariance is:

$$u(m_0,m_1) \approx \mathrm{cov}(m_0,m_1) \equiv \langle\Delta(m_0)\Delta(m_1)\rangle =$$
$$= \langle\Delta(m_0)[\Delta(m_0) + \Delta(k_1)]\rangle = \langle\Delta^2(m_0)\rangle + 0 = \langle\Delta^2(m_0)\rangle \approx u^2(m_0)$$

equal to the variance of m_0.

The significance of considering the covariances can be well demonstrated by deriving another standard m_2 from the standard m_0 measuring the difference $\{k_2,u(k_2)\}$. The variance of m_2 will be $u^2(m_2) = u^2(m_0) + u^2(k_2)$, similarly to (2). m_1 and m_2 are correlated as well. Their covariance is:

$$u(m_1,m_2) \approx \langle\Delta(m_1)\Delta(m_2)\rangle = \langle[\Delta(m_0) + \Delta(k_1)][\Delta(m_0) + \Delta(k_2)]\rangle = \langle\Delta^2(m_0)\rangle + 0 \approx u^2(m_0)$$

if k_1 and k_2 are also independent.

Defining the sum of m_1 and m_2 from the equation $m_+ \equiv m_1 + m_2$ for the error of m_+ it follows that $\Delta(m_+) = \Delta(m_1) + \Delta(m_2)$. From this for the variance of m_+ the following formula is obtained:

$$u^2(m_+) \approx \langle\Delta^2(m_+)\rangle = \langle[\Delta(m_1) + \Delta(m_2)]^2\rangle \approx u^2(m_1) + u^2(m_2) + 2u(m_1,m_2) = u^2(k_1) + u^2(k_2) + 4u^2(m_0)$$

Neglecting the fact that m_1 and m_2 are correlated, i.e. "forgetting" the covariance term $2u(m_1,m_2)$, the wrong expression given below would be obtained:

$$u^2(k_1) + u^2(k_2) + 2u^2(m_0) \tag{3}$$

In some cases this "forgetfulness" can cause some 30 % error in the uncertainty of measurement.

The importance of covariances can be better proved by taking the difference of m_1 and m_2. Calculating the variance of the difference $m_- = m_1 - m_2$ considering covariances, the uncertainty of the standard m_0 must be eliminated, since m_- is independent of m_0:

$$m_- = m_1 - m_2 = (m_0 + k_1) - (m_0 + k_2) = k_1 - k_2.$$

So $\Delta(m_-) = \Delta(m_1) - \Delta(m_2) = \Delta(k_1) - \Delta(k_2)$, thus the variance:

$$u^2(m_-) \approx \langle\Delta^2(m_-)\rangle = \langle[\Delta(m_1) - \Delta(m_2)]^2\rangle \approx u^2(m_1) + u^2(m_2) - 2u(m_1,m_2) = u^2(k_1) + u^2(k_2)$$

Supposing wrongly the independence of m_1 and m_2, i.e. $u(m_1,m_2) = 0$, the variance (3) would be given. When the uncertainties of the measured differences k_1 and k_2 are small in comparison to the uncertainty of the standard m_0, supposition of the independence is even more critical and cannot be "forgiven".

3.1.2 Derivation with constraint by redundant measurement of differences

The task of deriving standards is often made redundant in order to make the values of the derived standards more accurate by the method, that in addition to the measurements of $\{k_1,u(k_1)\}$ and $\{k_2,u(k_2)\}$, the difference $k_{12} \equiv m_1 - m_2$ is directly measured between the two derived standards.

So, three equations can be given for the two unknown quantities m_1 and m_2:

$$m_1 = m_0 + k_1$$
$$m_2 = m_0 + k_2$$
$$k_{12} = m_1 - m_2$$

It is obvious that the three equations are usually contradictory, since the number of unknown quantities is less than the number of equations. However, by definition the relations are valid for the true values (designated by capitals) of the above six quantities:

$$M_1 = M_0 + K_1$$
$$M_2 = M_0 + K_2$$
$$K_{12} = K_1 - K_2$$

Let us define the measured values (the measurement results) of m_1 and m_2 in the next form:

$$m_1 \equiv m_0 + k_1^* \text{ and } m_2 \equiv m_0 + k_2^*$$

where it is practical to define the quantities k_1^* and k_2^* as a linear expression of the measured differences k_1, k_2 and k_{12}:

$$k_1^* \equiv ak_1 + bk_2 + ck_{12} \text{ and } k_2^* \equiv dk_1 + ek_2 + fk_{12}$$

where *a, b, c, d, e* and *f* are constants.

Taking the true values of these two equations and requiring that the true value of k_1^* to be equal to K_1 and that the true value of k_2^* to be equal to K_2:

$$K_1 = aK_1 + bK_2 + c(K_1 - K_2) \text{ and}$$

$$K_2 = dK_1 + eK_2 + f(K_1 - K_2)$$

are obtained. Taking as equal the coefficients of K_1 and K_2 in the equations $a = 1 - c$, $b = c$, $d = -f$ and $e = 1 + f$, formulae are obtained. So:

$$k_1^* = (1 - c)k_1 + ck_2 + ck_{12} = k_1 + c(k_2 + k_{12} - k_1) \text{ and}$$

$$k_2^* = -fk_1 + (1 + f)k_2 + fk_{12} = k_2 + f(k_2 + k_{12} - k_1)$$

can be given. Since the true value $K_2 + K_{12} - K_1$ of the quantity $k_2 + k_{12} - k_1$ is equal to zero, k_1^* and k_2^* are unbiased estimations of the true values K_1 and K_2 respectively. Hence:

$$\Delta(k_1^*) = (1 - c)\Delta(k_1) + c\Delta(k_2) + c\Delta(k_{12}) \text{ and}$$
$$\Delta(k_2^*) = -f\Delta(k_1) + (1 + f)\Delta(k_2) + f\Delta(k_{12})$$

From here, supposing the independence of k_1, k_2 and k_{12}, for the variances:

$$u^2(k_1^*) \approx \langle\Delta^2(k_1^*)\rangle \approx (1 - c)^2u^2(k_1) + c^2u^2(k_2) + c^2u^2(k_{12})$$

$$u^2(k_2^*) \approx \langle\Delta^2(k_2^*)\rangle \approx f^2u^2(k_1) + (1 + f)^2u^2(k_2) + f^2u^2(k_{12})$$

relations are valid. Posing $U^2 \equiv u^2(k_1) + u^2(k_2) + u^2(k_{12})$, re-arranging and minimizing the upper equations with

$$\frac{\partial u^2(k_1^*)}{\partial c} \equiv 0 \text{ and } \frac{\partial u^2(k_2^*)}{\partial f} \equiv 0$$

we obtain $c = u^2(k_1)/U^2$ and $f = -u^2(k_2)/U^2$. Inserting these values back into the above formulae:

$$u^2(k_1^*) = u^2(k_1)(1 - c) \text{ and}$$
$$u^2(k_2^*) = u^2(k_2)(1 + f) = u^2(k_2)(1 - |f|)$$

Since c and $|f|$ are positive and always smaller than 1, the effect of optimization can well be seen: both variances $u^2(k_1^*)$ and $u^2(k_2^*)$ are less than they would be without the measurement of k_{12}.

Because the same measured values are used in their definition, k_1^* and k_2^* are correlated, and their covariance is:

$$u(k_1^*,k_2^*) \approx \langle\Delta(k_1^*)\Delta(k_2^*)\rangle = \langle[(1-c)\Delta(k_1) + c\Delta(k_2) + c\Delta(k_{12})]$$
$$[-f\Delta(k_1) + (1+f)\Delta(k_2) + f\Delta(k_{12})]\rangle =$$
$$= \langle -f(1-c)\Delta^2(k_1) + c(1+f)\Delta^2(k_2) + cf\Delta^2(k_{12})\rangle + 0 \approx$$
$$\approx -f(1-c)u^2(k_1) + c(1+f)u^2(k_2) + cfu^2(k_{12}) =$$
$$= c|f|[U^2(1-c) + U^2(1+f) - u^2(k_{12})] = c|f|U^2 = \frac{u^2(k_1)u^2(k_2)}{U^2}$$

Supposing that the measured differences k_1, k_2 and k_{12} are also independent of m_0, the variances of the unknown quantities m_1 and m_2 are:

$$u^2(m_1) \approx \langle\Delta^2(m_1)\rangle = \langle[\Delta(m_0) + \Delta(k_1^*)]^2\rangle \approx u^2(m_0) + u^2(k_1^*) \text{ and}$$
$$u^2(m_2) \approx \langle\Delta^2(m_2)\rangle = \langle[\Delta(m_0) + \Delta(k_2^*)]^2\rangle \approx u^2(m_0) + u^2(k_2^*)$$

Because m_1 and m_2 are correlated (here by the presence of m_0 since it is common in them that both standards are derived from the same primary standard m_0), and they are based on the same measured differences k_1, k_2 and k_{12}, their covariance is:

$$u(m_1,m_2) \approx \langle\Delta(m_1)\Delta(m_2)\rangle = \langle[\Delta(m_0) + \Delta(k_1^*)]$$
$$[\Delta(m_0) + \Delta(k_2^*)]\rangle = \langle\Delta^2(m_0) + \Delta(k_1^*)\Delta(k_2^*)\rangle$$

because m_0 is independent of k_1^* and k_2^*.

Hence $u(m_1,m_2) = u^2(m_0) + u(k_1^*,k_2^*)$

For the variance of the sum $m_+ = m_1 + m_2$

$$u^2(m_+) \approx \langle \Delta^2(m_+) \rangle = \left\langle [\Delta(m_1) + \Delta(m_2)]^2 \right\rangle \approx$$

$$\approx u^2(m_1) + u^2(m_2) + 2u(m_1, m_2) =$$

$$= [u^2(m_0) + u^2(k_1^*)] + [u^2(m_0) + u^2(k_2^*)] + 2[u^2(m_0) + u(k_1^*, k_2^*)] =$$

$$= 4u^2(m_0) + u^2(k_1) + u^2(k_2) - \frac{[u^2(k_1) - u^2(k_2)]^2}{U^2}$$

while for the variance of the difference $m_- = m_1 - m_2$

$$u^2(m_-) \approx \langle \Delta^2(m_-) \rangle = \left\langle [\Delta(m_1) - \Delta(m_2)]^2 \right\rangle \approx$$

$$\approx u^2(m_1) + u^2(m_2) - 2u(m_1, m_2) =$$

$$= [u^2(m_0) + u^2(k_1^*)] + [u^2(m_0) + u^2(k_2^*)] - 2[u^2(m_0) + u(k_1^*, k_2^*)] =$$

$$= u^2(k_{12})\left(1 - \frac{u^2(k_{12})}{U^2}\right)$$

can be given. If m_1 and m_2 were taken as independent, for the variance of their sum and difference the same value could be obtained:

$$u^2(m_1) + u^2(m_2) = u^2(m_0) + u^2(k_1^*) + u^2(m_0) + u^2(k_2^*) =$$

$$= 2u^2(m_0) + u^2(k_{12}) + \frac{2u^2(k_1)u^2(k_2) - u^4(k_{12})}{U^2}$$

In the case of the sum this variance is less than the correct value, while this wrong variance of the difference is much bigger than the correct one, which may be near to zero. To illustrate these facts let a new quantity z be brought in, which is defined as the ratio of the above "wrong" variance to the "right" one. Assuming that $u^2(k_1) \approx u^2(k_2) \approx u^2(k_{12}) \equiv u^2$, the following two unequations can easily be proved:

for $u^2(m_+)$: $\frac{1}{2} < z(m_+) < \frac{2}{3}$ and

for $u^2(m_-)$: $2 < z(m_-) < \infty$ (!)

The limits of the ratio z can be obtained by the assumption:

either $\frac{u^2(m_0)}{u^2} \to 0$ or $\frac{u^2}{u^2(m_0)} \to 0$ respectively.

3.1.3 Measurement performed by an instrument with constant systematic error

From the point of mathematics the derivation from the same standard and the measurement performed by an instrument with constant systematic error are equivalent. Let $\{x_1,u(x_1)\}$ and $\{x_2,u(x_2)\}$ be the results of measurements of two different measurands. It is assumed that the measurements were performed by the same instrument with constant systematic error Δ_s. Let μ_1 designate the expected value, and τ_1 the true value of X_1. The similar designations for X_2 are μ_2 and τ_2. For the systematic errors it follows from the assumption that $\mu_1 - \tau_1 = \mu_2 - \tau_2 = \Delta_s$. So, for the measurement errors:

$\Delta(x_1) \equiv x_1 - \tau_1 \equiv (x_1 - \mu_1) + (\mu_1 - \tau_1) \equiv (x_1 - \mu_1) + \Delta_s$, and

$\Delta(x_2) \equiv x_2 - \tau_2 \equiv (x_2 - \mu_2) + \Delta_s$ can be given.

From here the estimates of the variances are:

$$u^2(x_1) \approx \langle \Delta^2(x_1) \rangle = \left\langle (x_1 - \mu_1)^2 \right\rangle + 2\Delta_s \langle x_1 - \mu_1 \rangle + \Delta_s^2 =$$

$$= \sigma^2(x_1) + 0 + \Delta_s^2 \approx s_1^2 + h_s^2 \qquad (4)$$

and similarly

$$u^2(x_2) = s_2^2 + h_s^2 \qquad (5)$$

where s_1^2 and s_2^2 are the estimates of the variances characterizing the random errors, and h_s^2 is the estimate of the square of the common systematic error Δ_s. Assuming the independence of the random errors of x_1 and x_2, the *metrological covariance*[1] of the two results is:

$$u(x_1, x_2) \approx \langle \Delta(x_1)\Delta(x_2) \rangle = \langle (x_1 - \tau_1)(x_2 - \tau_2) \rangle \equiv$$

$$\equiv \langle [(x_1 - \mu_1) + \Delta_s][(x_2 - \mu_2) + \Delta_s] \rangle = \Delta_s^2 \approx h_s^2 \qquad (6)$$

In all aspects h_s^2 "behaves" similarly to $u^2(m_0)$ in the above examples.

Some years ago the international documents suggested handling the "systematic" and the "random" uncertainties separately. Nowadays on the basis of the documents, even these denominations must be avoided; the uncertainty components must be handled in the same, uniform way and their origin need not be taken into consideration. Formulae (4) and (5) prove the usefulness of the new suggestions, while formula (6) is in contradiction with them. In the variances of x_1 and x_2 both the systematic and the random components behave in similar manner, but the covariance depends on the origin of the error.

1 The term *covariance* here is used not in a clearly statistical sense, because the errors here are taken in the *metrological sense*, i.e. they are defined as the differences of the measurement result and not the expectation but the true value.

3.1.4 Derivation in several steps by measurement of the differences

It is assumed here that the value of the standard $\{m_j,u(m_j)\}$ at the j^{th} level is derived from the primary standard $\{m_0,u(m_0)\}$ in several steps by the measurements of the differences $\{k_j,u(k_j)\}$, using the formula:

$$m_j \equiv m_{j-1} + k_j \equiv m_0 + \sum_{l=1}^{j} k_l$$

If the differences k_j are independent of each other and of m_0, the variance of m_j equals to:

$$u^2(m_j) = u^2(m_{j-1}) + u^2(k_j) \equiv u^2(m_0) + \sum_{l=1}^{j} u^2(k_l)$$

Taking into consideration another i^{th} level $(i > j)$ making use of m_j, m_j and m_i will be correlated; their covariance

$$u(m_j, m_i) \approx \langle \Delta(m_j)\Delta(m_i)\rangle = \left\langle \Delta(m_j)\left[\Delta(m_j) + \sum_{l=j+1}^{i}\Delta(k_l)\right]\right\rangle =$$

$$= \langle \Delta^2(m_j)\rangle \approx u^2(m_j)$$

is equal to the variance of the standard at the j^{th} level. It is useful to determine the correlation coefficient of m_j and m_i:

$$r(m_j, m_i) = \frac{u(m_j, m_i)}{u(m_j)u(m_i)} = \frac{u(m_j)}{u(m_i)}$$

In this case the correlation coefficient is always positive and, of course, less than 1, since $u(m_i)$ is always bigger than $u(m_j)$, because $u^2(m_i)$ "contains" $u^2(m_j)$. The farther apart the j^{th} and i^{th} levels are, the slighter the interdependence of m_j and m_i. Only when the condition $u^2(m_{j+1}) >> u^2(m_j)$ is fulfilled can m_j and m_{j+1} be taken as "independent". If the "accuracy ratio" between two adjacent levels is always bigger then 4:1, this condition is usually fulfilled.

The foregoing examples show that all standards derived from the same primary standard are correlated. Hence the results of measurements, performed by instruments derived from the same primary standard, are correlated as well. If the value of the "accuracy ratio" between two adjacent levels is always bigger than 4:1 or better yet 5:1, the results of measurements can be taken as "independent", when the instruments in question are derived from different levels. In the case of measurements performed by instruments "of the same level", it is useful to be careful, especially when measuring a difference.

3.1.5 Derivation of several standards by measurement of differences

The derivation of secondary standards from the primary one is often performed by using a travelling standard, the value of which is designated by $\{m_T,u(m_T)\}$. Let $\{m_l,u(m_l)\}$ designate the value of the l^{th} standard from N, which is derived from the same travelling standard by direct measurement of the difference $\{k_l,u(k_l)\}$. Here $m_l = m_T + k_l$, and because of $\Delta(m_l) = \Delta(m_T) + \Delta(k_l)$ for the variances

$$u^2(m_l) = u^2(m_T) + u^2(k_l) \qquad (7)$$

are valid, if the value of the difference k_l is independent of the value of the travelling standard. The standards derived this way are not independent, of course. The covariance of the i^{th} and l^{th} standards is:

$$u(m_i, m_l) \approx \langle \Delta(m_i)\Delta(m_l)\rangle \equiv \langle [\Delta(m_T) + \Delta(k_i)][\Delta(m_T) +$$

$$+ \Delta(k_l)]\rangle \approx u^2(m_T)$$

This fact has a great importance when comparing standards derived in the same way (see 3.4.2).

3.2 Step by step derivation by measurement of ratios

The only difference between this example and the case shown in 3.1.4 is that the value of the standard at the j^{th} level can be determined from the $(j-1)^{th}$ level by measurement not of the differences, but of the ratios $\{a_j,u(a_j)\}$ on the basis of the expression:

$$m_j = a_j m_{j-1} \equiv m_0 \prod_{l=1}^{j} a_l$$

Since all the quantities concerned are positive, the logarithm of both sides of this equation can be taken:

$$\ln m_j = \ln m_0 + \sum_{l=1}^{j} \ln a_l$$

From here the error

$$\Delta(\ln m_j) = \Delta(\ln m_0) + \sum_{l=1}^{j} \Delta(\ln a_l)$$

and the relative error in the first approximation:

$$\frac{\Delta(m_j)}{m_j} \approx \frac{\Delta(m_0)}{m_0} + \sum_{l=1}^{j}\frac{\Delta(a_l)}{a_l}$$

since for a positive quantity x $\Delta(\ln x) \approx \Delta(x) / x$

Hence for the relative variance of m_j

$$\frac{u^2(m_j)}{m_j^2} = \frac{u^2(m_0)}{m_0^2} + \sum_{l=1}^{j} \frac{u^2(a_l)}{a_l^2}$$

can be given, if the ratios a_1 are independent of each other and of m_0.

It can be seen that this example is analogous to the case of derivation by measurement of differences, if the ratios a are used instead of the differences k and the relative variances and covariances are used instead of absolute ones. So, all the conclusions are similar, with the necessary modifications, of course.

It is not much more complicated to handle the case, when the combination of ratio and difference measurements are used, i.e. when the value of the standard on the j^{th} level is derived from the $(j\text{-}1)^{th}$ level on the basis of the expression $m_j = a_j m_{j-1} + k_j$

3.3 One measurement, several results

3.3.1 Indirect measurement with two output quantities

In the simplest case, the input quantity X is determined by direct measurement and the (output) result quantities Y_1 and Y_2 are determined by calculations, using the model functions $Y_1 = H_1(X)$ and $Y_2 = H_2(X)$. If the measurement result for X is $\{x,u(x)\}$, then $y_1 = H_1(x)$, $y_2 = H_2(x)$, $\Delta(y_1) \approx H_1'\Delta(x)$, $\Delta(y_2) \approx H_2'\Delta(x)$, so $u^2(y_1) = H_1'^2 u^2(x)$, and $u^2(y_2) = H_2'^2 u^2(x)$. The covariance of y_1 and y_2 is:

$$u(y_1,y_2) \approx <\Delta(y_1)\Delta(y_2)> \approx H_1'H_2'u^2(x)$$

Let us take a simple example. If the directly measured diameter of a sphere is $\{d,u(d)\}$, then for its calculated surface $\{f,u(f)\}$ and for its volume $\{v,u(v)\}$ on the basis of the well known geometrical formulae and the above mentioned expressions:

$$f = \pi d^2$$

$$v = \pi d^3/6$$

$$\Delta(f) \approx 2\pi d\Delta(d)$$
$$\Delta(v) \approx 3\pi d^2\Delta(d)/6 = \pi d^2\Delta(d)/2$$

$$u^2(f) \approx \langle\Delta^2(f)\rangle \approx \langle[2\pi d\Delta(d)]^2\rangle \approx 4\pi^2 d^2 u^2(d)$$

$$u^2(v) \approx \langle\Delta^2(v)\rangle \approx \left\langle\left[\frac{\pi d^2\Delta(d)}{2}\right]^2\right\rangle \approx \pi^2 d^4 u^2(d)/4$$

$$u(f,v) \approx \langle\Delta(f)\Delta(v)\rangle \approx \left\langle 2\pi d\Delta(d)\frac{\pi d^2\Delta(d)}{2}\right\rangle \approx \pi^2 d^3 u^2(d)$$

can be given. The surface f and the volume v are correlated, since $u(f,v) \neq 0$; (the estimate of) their linear correlation coefficient is:

$$r(f,v) = \frac{u(f,v)}{u(f)u(v)} = 1$$

The unit value for r indicates the strongest possible mutual dependence. This fact is not unexpected at all, since f and v are functions of each other:

$$v = \frac{f^{3/2}}{6\sqrt{\pi}}$$

From the data for the surface and the volume, the characteristics of the diameter can easily be found as:

$$d = \frac{6v}{f} \quad \text{and from here}$$

$$\Delta(d) \approx \frac{6\Delta(v)}{f} - \frac{6v\Delta(f)}{f^2} \quad \text{hence}$$

$$u^2(d) \approx \langle\Delta^2(d)\rangle \approx \frac{36u^2(v)}{f^2} + \frac{36v^2u^2(f)}{f^4} - \frac{72vu(f,v)}{f^3}$$

Putting the known values of f, v, $u^2(f)$, $u^2(v)$ and $u(f,v)$ into the last formula, the original value of $u^2(d)$ can be retrieved. **Neglecting the fact** that f and v are **strongly correlated**, i.e. taking zero value in the place of the covariance $u(f,v)$, the formula gives a value for the variance $u^2(d)$ that is **13 (!) times bigger than the correct original value,** so the standard deviation of the diameter is approximately four times bigger than the correct value. This "luxury" cannot be allowed even in the case when "only" the measurement uncertainty is concerned.

3.3.2 Fitting a straight line

Let us take the next assumptions:

a) The measured pairs (x_k,y_k) belonging together are known $(k = 1, 2, \ldots, n)$;

b) the uncertainty of every x_k is equal to zero, while the uncertainty of the y_k values can be characterized by the same, common u_y^2, i.e. $u^2(x_k) = 0$ and $u^2(y_k) = u_y^2$ $(k = 1, 2, \ldots, n)$;

c) y_k and y_j are independent, if $k \neq j$.

The task is to determine the slope $\{m,u(m)\}$ and the intersection $\{b,u(b)\}$ of the straight line $y = mx + b$, that characterizes the assumed linear function between X and Y. If the above conditions are fulfilled, usually the function:

$$G \equiv \sum_{k=1}^{n} (y_k - mx_k - b)^2$$

is minimized according to m and b.

Using the designations

$$p \equiv \frac{1}{n}\sum_{k=1}^{n} x_k,\ q \equiv \frac{1}{n}\sum_{k=1}^{n} y_k,\ v \equiv \frac{1}{n}\sum_{k=1}^{n} x_k^2,\ w \equiv \frac{1}{n}\sum_{k=1}^{n} x_k y_k \text{ and}$$

$$z \equiv \frac{1}{n}\sum_{k=1}^{n} y_k^2$$

$$G/n \equiv m^2 v - 2mw + 2mbp + b^2 - 2bq + z$$

The least squares solution of the task on the basis of the conditions $\partial G/\partial m \equiv 0$ and $\partial G/\partial b \equiv 0$

$$m = \frac{w - pq}{v - p^2} \text{ and}$$

$$b = q - mp$$

Since according to assumption b) $\Delta(p) = 0$ and $\Delta(v) = 0$, for the error $\Delta(m)$

$$\Delta(m) \approx \frac{\Delta(w) - p\Delta(q)}{v - p^2} \quad \text{and from this}$$

$$u^2(m) \approx \langle \Delta^2(m) \rangle \approx \frac{u^2(w) + p^2 u^2(q) - 2pu(w,q)}{\left(v - p^2\right)^2}$$

can be given.

With respect to the definition of w and q and using assumption b),

$$\Delta(w) = \frac{1}{n} \sum_{k=1}^{n} x_k \Delta(y_k) \text{ and}$$

$$\Delta(q) = \frac{1}{n} \sum_{k=1}^{n} \Delta(y_k). \text{ From here}$$

$$u^2(w) \approx \langle \Delta^2(w) \rangle = \left\langle \frac{1}{n^2} \sum_{k=1}^{n}\sum_{j=1}^{n} x_k x_j \Delta(y_k)\Delta(y_j) \right\rangle =$$

$$= \frac{1}{n^2}\sum_{k=1}^{n} x_k^2 \langle \Delta^2(y_k) \rangle \approx \frac{1}{n^2}\sum_{k=1}^{n} x_k^2 u_y^2 = \frac{u_y^2 v}{n}$$

and similarly $u^2(q) \approx \langle \Delta^2(q) \rangle \approx \dfrac{u_y^2}{n}$ and

$$u(w,q) \approx \langle \Delta(w)\Delta(q) \rangle \approx \frac{u_y^2 p}{n}$$

Hence:

$$u^2(m) = \frac{u_y^2}{n(v - p^2)} \text{ is the variance of the slope } m,$$

$$u^2(b) = \frac{u_y^2 v}{n(v - p^2)} \equiv v u^2(m)$$

is the variance of the intersection b, and

$u(m,b) = -pu^2(m)$ is the covariance of m and b.

The two results, m and b, **obtained from one measurement are correlated.** As an application of the straight line, for an arbitrary x let the reading y and its uncertainty $u^2(y)$ be determined. For y, of course, $y = mx + b$ is valid, from which for the error of y:

$$\Delta(y) = x\Delta(m) + \Delta(b), \text{ and}$$

$$u^2(y) \approx \langle \Delta^2(y) \rangle \approx x^2 u^2(m) + u^2(b) + 2xu(m,b) =$$
$$= u^2(m)\,[x^2 + v - 2xp] \equiv u^2(m)[(x - p)^2 + v - p^2]$$

The above formula confirms the fact, well known from the literature, that the uncertainty of the reading y is minimum, when $x = p$, i.e. when the reading is made at the "center of gravity" of the values x_k used for fitting the line. If we used $u^2(y) = u^2(m)(x^2 + v)$, i.e. **neglecting the covariance** $u(m,b)$, **the result would be a nonsense:** because the uncertainty of the reading y would be minimum only at $x = 0$, despite the fact that the straight line perhaps does not have (physical) sense there.

At the same time this example shows that the person carrying out the measurement must not only give the measurement results and their uncertainties but the covariances too, when several results belong to the same measurement and it can be supposed that more than one result is used simultaneously.

3.4 Several measurements, one result

3.4.1 Intercomparison, the uncertainty of the physical constants

From the point of view of mathematics in the intercomparison and in the evaluation of the physical constants it is common that for a given quantity X more than one $\{x_k, u(x_k)\}$ measurements are available, and the optimized measurement result can be determined on the basis of them.

If the optimized result x is given in the obvious form of a weighted average

$$x \equiv \sum_{k=1}^{n} g_k x_k$$

where $\sum_{k=1}^{n} g_k = 1$, then its error is $\Delta(x) = \sum_{k=1}^{n} g_k \Delta(x_k)$, and its variance, *supposing that the measurement results* x_k *are independent of one another,* is:

$$u^2(x) \approx \langle \Delta^2(x) \rangle = \sum_{k=1}^{n}\sum_{j=1}^{n} g_k g_j \langle \Delta(x_k)\Delta(x_j) \rangle = \tag{8}$$

$$= \sum_{k=1}^{n} g_k^2 \langle \Delta^2(x_k) \rangle + 0 \approx \sum_{k=1}^{n} g_k^2 u^2(x_k)$$

If the weighting factors g_k are chosen to minimize the variance $u^2(x)$ and to fulfil the condition $\sum_{k=1}^{n} g_k = 1$, by the use of the Lagrange method the function

$G \equiv \sum_{k=1}^{n} g_k^2\, u^2(x_k) + \lambda \sum_{k=1}^{n} g_k$ must be derived with respect to the g_k values, and the derivatives must be taken equal to zero, where λ is the Lagrange-multiplicator:

$$0 \equiv \frac{\partial G}{\partial g_k} = 2 g_k u^2(x_k) + \lambda$$

From here the weighting factors are obtained:

$$g_k = -\lambda / 2u^2(x_k)$$

Since $\sum_{k=1}^{n} g_k$ must be equal to the unit,

$$1 = -\frac{\lambda}{2} \sum_{k=1}^{n} \frac{1}{u^2(x_k)}$$

The λ value can be determined from here. With this value of λ the weighting factors:

$$g_k = \frac{1}{u^2(x_k) \sum_{j=1}^{n} \frac{1}{u^2(x_j)}}$$

Inserting these values into formula (8) of $u^2(x)$

$$\frac{1}{u^2(x)} = \frac{1}{\sum_{k=1}^{n} g_k^2 u^2(x_k)} = \frac{1}{\sum_{k=1}^{n} g_k [g_k u^2(x_k)]} = \frac{\sum_{j=1}^{n} \frac{1}{u^2(x_j)}}{\sum_{k=1}^{n} g_k} = \sum_{j=1}^{n} \frac{1}{u^2(x_j)} \tag{9}$$

can be given.

So the uncertainty of the result, obtained by optimization, is less than the minimum of the uncertainties of the input data.

As shown above the measurement result x and all the input data x_j must be correlated, since x originates from the input data x_j; their covariance is:

$$u(x, x_j) \approx \langle \Delta(x)\Delta(x_j) \rangle = \left\langle \sum_{k=1}^{n} g_k \Delta(x_k)\Delta(x_j) \right\rangle =$$

$$= g_j \langle \Delta^2(x_j) \rangle + 0 \approx g_j u^2(x_j) \equiv u^2(x)$$

Why is it so important that x and x_j are correlated?

It can be seen from (9) that every new *independent* data reduces the variance $u^2(x)$ of the result x. If someone had the logical but strange idea to decrease the uncertainty $u^2(x)$ by the repeated use of the data x_j (that was used for calculation of x once), calculation of the covariance would "automatically" persuade that person not to do so.

In this case the "twice optimized" result (that is designated by x^*) can be written in the form of $x^* \equiv ax + (1 - a)x_j$, where a and $1 - a$ are the weighting factors, whose sum is equal to the unit. The error of x^* is $\Delta(x^*) = a\Delta(x) + (1 - a)\Delta(x_j)$, and its variance is

$$u^2(x^*) = a^2u^2(x) + (1 - a)^2u^2(x_j) + 2a(1 - a)u(x,x_j)$$

Minimizing this expression with respect to a and using the value $u(x,x_j) = u^2(x)$, the result will be $a = 1$, therefore $x^* = x$ and $u(x^*) = u(x)$; so the "second optimization" will not lead to the increase of the accuracy. Neglecting the covariance $u(x,x_j)$ the uncertainty of x^* would decrease virtually, and repeating this "method" enough times the uncertainty $u(x)$ could become equal to zero. The zero value of the uncertainty of the result "optimized" **without covariances** is not reasonable and is **in contradiction with logic**. This can be explained as follows: if the optimized result x were combined with the same x_j several times, after infinite repetition, the optimized result would be equal to x_j, and this value would have two different uncertainties simultaneously: the original $u(x_j)$ and the zero.

When expressing the official values of the physical constants, it is very important to only consider independent, original and clear sources.

3.4.2 Intercomparison, dependent data

Let us suppose that the metrological parameters of the correlated standards mentioned in 3.1.5 are checked in the following way. The same quantity X, sent off from a calibration center, is measured by every standard $\{m_l, u(m_l)\}$, and the results $\{x_l, u(x_l)\}$ are sent back to the center. If the result in the l^{th} laboratory is determined using the difference $k_l^* \equiv x_l - m_l$, then $\Delta(x_l) = \Delta(m_l) + \Delta(k_l^*)$. From here supposing the independence of m_l and k_l^*

$$u^2(x_l) = u^2(m_l) + u^2(k_l^*)$$

where every variance $u^2(m_l)$ contains a common component $u^2(m_T)$ causing correlation according to formula (7), since it is assumed that every standard is derived from the same travelling standard $\{m_T, u(m_T)\}$. So:

$$u^2(x_1) = u^2(m_T) + u^2(k_1) + u^2(k_1^*)$$

and

$$u(x_i, x_l) \approx \langle \Delta(x_i)\Delta(x_l) \rangle = \langle [\Delta(m_i) + \Delta(k_i^*)][\Delta(m_l) + \Delta(k_l^*)] \rangle =$$

$$= \langle \Delta(m_i)\Delta(m_l) \rangle \approx u(m_i, m_l) = u^2(m_T)$$

If the center's measurement result $x = \sum_{l=1}^{N} g_l x_l$ is determined to have a minimal variance $u^2(x)$ on the basis of the returned data $\{x_l, u(x_l)\}$, then it must be taken into consideration that the returned data are correlated.

Namely $\Delta(x) = \sum_{l=1}^{N} g_l \Delta(x_l)$, and so

$$u^2(x) = \langle \Delta^2(x) \rangle = \sum_{l=1}^{N}\sum_{i=1}^{N} g_l g_i \langle \Delta(x_l)\Delta(x_i) \rangle \approx$$

$$\approx \sum_{l=1}^{N} g_l^2 u^2(x_l) + \sum_{l=1}^{N}\sum_{i \neq l}^{N} g_l g_i u(x_i, x_l) =$$

$$= u^2(m_T) + \sum_{l=1}^{N} g_l^2 [u^2(k_l) + u^2(k_l^*)]$$

Comparing this formula with expression (8) it can be seen that *in contradiction with the case of the independent returned data*, during the optimization, the random components $u^2(k_1) + u^2(k_1^*)$ of the uncertainties of the returned data should only be used instead of the total uncertainty $u^2(x_1)$, which contains the common systematic component $u^2(m_T)$ too.

This is the second case in this paper when because of the covariances the errors and consequently their estimations, the uncertainties are "splitting" like the lines in spectroscopy. Independently of our will, *nature* distinguishes between random and systematic errors not only during their origination, but throughout their "lifespan" (handling) as well.

It can also be deduced from the above formula that independently of the number of the returned data the variance of the optimized result cannot be decreased under the variance $u^2(m_T)$ of the travelling standard, when the returned data are correlated. Another curiosity: in the previous examples the covariances did not influence the measurement results, they only influenced the uncertainties associated with the results. In this example the optimized result x depends on the weighting factors g_l, that are dependent on the covariances.

This simplified example can well demonstrate the more general fact that the standards, derived from the same standard, are always correlated and not only for the measurement of differences; this fact cannot be neglected when comparing these standards.

4 Conclusions

Literature on measurement uncertainty never omits to mention that the covariances must be taken into consideration when handling correlated data, but most often particular guidelines for the cases when the covariances can be neglected are provided. In this paper some examples are provided that can be applied within metrological practice. These cases prove that the covariances can be simply handled, and neglecting them can cause large errors in evaluating the measurement uncertainty.

The examples also point out that the data are usually correlated if they have a common "ancestor", and when in close "propinquity", the dependence is stronger.

An interesting contradiction arises as recent literature on measurement uncertainty suggests:

1) not to distinguish the "random" and the "systematic" uncertainties, moreover to avoid their use, if possible; and
2) to take the covariances into consideration, if necessary.

As it was shown, from the point of view of mathematics, sometimes these two suggestions contradict each other, since occasionally the covariances "feel" the origin of the components of the measurement uncertainty, and in these cases, the source (the origin) cannot be neglected.

The author hopes that the examples provided in this paper can help in deciding when the covariances *must be used* and in showing cases that should be considered as *suspicious*. ■

5 Reference

[1] "Guide to the Expression of Uncertainty in Measurement"; BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML: 1995.

METHODOLOGY

Verification of flow computers

I.F. CRETU, Head of Measuring Systems Laboratory, National Institute of Metrology, Bucharest, Romania

Abstract

Experiments carried out over several years focusing on type approval testing and verification of flow computers have led the author to formulate a proposal for a general metrological approach to verifying these devices.

Research shows that flow computers are used both as measuring instruments and as information acquisition/ processing devices; accordingly, they must be verified under varying operational conditions.

Taking into account both the extent of the problem and the need for a coherent approach for all types of flow computer, a global verification methodology has been defined. The limits of a number of parameters as well as information specific to each type of device should be included in normative documentation on the product.

1 Background

Flow computers are specialized microcomputer-based measuring devices intended for fluid flow calculation and fluid volume correction and measurement; they process information generated by specific sensors and transducers (flow, volume, density, pressure, temperature, etc.). Inherent calculation functions generally reproduce theoretical models or are regulated by standards, most of which are accepted worldwide [1, 3–7, 11].

Flow computers also carry out certain functions intended to control fluid flow processes or user-generated information concerning specific situations (e.g. alarms, journals at certain time intervals, etc.).

2 Brief presentation

Flow computers, as they are used today, first appeared at the beginning of the 1980's – at that time they represented a significant development in practical methods of fluid volume measurement.

At the outset, 8-bit all-purpose microprocessors (e.g. INTEL 8080, Z 80) were used; then, step by step, 16-bit microprocessors (still used nowadays) were introduced whose architecture was better adapted to specific acquisition and calculation processes (e.g. INTEL 80C188, MOTOROLA 68000). In the meantime, input blocks were built using 12-bit converters. Gradually, higher performance converters were used, the latest types having efficient self-calibration facilities that guarantee performance over a longer period, sometimes more than one year.

The first flow computer programs transformed the device into a rigid structure that the manufacturer defined as totally non-programmable. Later, programs allowed the user to introduce some parameters specific to his application ("parameterizing" computers), followed by the possibility for the user to alter the configuration ("configurable" computers). Now it is possible to fully modify the programmed applications ("definable" systems). It is the increase in addressable memory (now exceeding 1 Mb) that made these evolutions possible.

The operation of flow computers (configuration, input of parameters, performance verification) is carried out by simulator devices and specialized user-friendly programs that facilitate the safe handling of a significant volume of information so that the user should not necessarily be aware of all the details of the internal process.

Finally, the current speed of calculation and memory capacity have led to important developments in the field of communications. Every flow computer now has at least two interfaces whereby it can communicate digitally with the operator, as well as with the system transducers or with a hierarchically superior system (the "master").

These new possibilities of data acquisition, processing, transmission and configuration mean that control of the devices during commercial transactions (e.g.

Table 1 Flow computer as a measuring device

Fluid to be measured	Gas		Natural gas Steam Other gases
	Liquid		Water Crude oil and petroleum products Other liquids
Sensor (main transducer of the defined application)	Function	Flow	Volume Mass
		Quantity	Volume Mass
	Type of construction	Non-linear	Orifice Nozzle Others
		Linear	Turbine, Vortex, Coriolis, others

Table 2 Flow computer as an information processing device

Types of application		Non-programmable Parameterizing Configurable Definable
Types of connections	Analogue	Current Voltage
	Impulse	Current Voltage
	Interface	RS 232 RS 422 RS 485 Other types

custody transfer) has become a delicate and onerous operation that must follow a rigorous procedure in accordance with the model, application and configuration. Every one of these steps serves to guarantee that the device operates according not only to its own specifications but also to normative requirements and to national trade practices.

3 Functional groups

Since flow computers are both measuring and information processing devices, it is functionally efficient to group them according to two main criteria. As a measuring device, the criteria presented in Table 1 are possible.

Taking into account this first classification criteria, the following comments are useful:

- if the main sensor (transducer) is a quantity sensor (volume or mass), flow calculation becomes secondary (flow is calculated relating the quantity to the time interval, the flow computer being mainly a volume corrector);
- although informative and useful for the orientation of the application and verification procedure, this classification enables devices (according to their configuration) to be split into two different categories (e.g. an orifice application may be a mass flowmeter if it includes, as a main function, a densitometer or it may be a volume flowmeter if it does not include such a device; then, fluid volume is displayed as the main parameter);
- using some main transducers (e.g. Coriolis or Vortex) which may be simultaneously present at different output terminals, flow and quantity (volume or mass) transducers, the flow computer will be the same type;
- practically, and especially for transaction purposes, not all class combinations are possible or available.

As an information processing device, the general classification criteria set out in Table 2 are possible.

Referring to the classification according to the connection type, the following should be mentioned [13–17]:

- a flow computer can be fitted with many types of connections at the same time - e.g. it can have an analogue connection with some part of the transducers, an impulse connection with others, or an RS 232 interface to the operator terminal or an RS 485 interface to the supervisor computer;
- while connection with transducers significantly influences the computer's accuracy, protection against undesired access depends on the way in which the flow computer is connected to the supervisor computer.

The type of application is the main element to establish the information sources in order to verify the computer, thus:

- for a non-programmable computer, the only source of information is the technical documentation supplied by the manufacturer;
- for a parameterizing computer, some parameters (e.g. measuring intervals for transducers, different limit values, coefficients, etc.) may be defined by the user;
- a configurable computer also enables the number and types of transducers to be chosen from a list, together with an alternative calculation method, output signal programming as well as the possibility to connect certain auxiliary equipment (e.g. a printer);
- the definition of the type of application (fluid nature, measurement method) in the case of a definable application computer may be carried out in two ways:
  - by using the corresponding EPROM memories;
  - by a software option when many applications are resident in the computer's memory.

Programmable computers are devices in which the calculation function required a new verification process method in which a significant part of the information is defined by the user. Thus, traditional performance verification should be carried out only when all the configuration elements are defined.

4 Errors and uncertainties

In the case of flow computers, three categories of errors can be defined:

A. Partial relative error, δ, characteristic of every input block, expressed by the established relation:

$$\delta = \frac{X - V}{V} \qquad (1)$$

where: X = the measured value;
V = the corresponding conventional true value.

The error δ can refer directly to the input quantity (current, voltage, frequency) or to the physical parameter represented by the input quantity (pressure, temperature, density, etc.).

It should be mentioned that input block means not only the physical input circuit but also the program sequences that process the measured values until they reach the final state (i.e. stored or displayed).

The limits of these relative errors are most often expressed according to the measurement range (full scale deflection), but sometimes also according to the measured value.

B. Global relative error consists of the relative difference between the flow, volume or correction coefficient value calculated by the flow computer and the conventional true value of the same quantity when determined values for all inputs are simulated.

The experiment determining the global error is a multi-factorial experiment, the number of input parameters as a rule being 2 to 4. The global error is generally dependent on the operation point in a space of two, three or four dimensions.

Practically, it is obvious that an exhaustive analysis of this error function can be difficult during a verification operation, but the determination of a single value (e.g. maximum permissible error) is possible.

An alternative solution for the objective characterization of the accuracy level of the device is the estimation of uncertainty by which the fluid flow or volume or correction coefficient is measured if partial and if calculation errors are known. Further, this uncertainty will be referred to as global uncertainty.

It is obvious that such a problem does not have a single solution and it should be approached taking into account the particular recommendations of standards on measurement methods [1–6]. Sometimes a single algebraic addition and sometimes a square composition of partial errors is recommended at a confidence level of 95 %.

Based on the assumptions below, as initial premises:

- uniform distribution of the input variables in the range determined by the input block errors;
- uncertainty estimation at a confidence level of 95 %;
- separation of instrumental errors from the method ones during the intermediate steps of the calculation using determined values of global errors as a comparison element in order to calibrate the free options of the calculation method.

Realistic estimation can be obtained in all these cases.

Finally, it should be mentioned that a simple and efficient solution to limiting global error can be found, namely the association of this value to other characteristic (maximum and minimum flow ratios, Q_{max}/Q_{min}, input pressure range, etc.).

C. Calculation relative error: this notion is often used as an expression of the relative difference between a parameter value calculated by the flow computer and the same value calculated by a conventional standard program. Thus defined, the calculation relative error can be considered as a preliminary expression of the global relative error.

5 Verification methods

Flow computer verification is the operation that guarantees that the device meets the technical requirements specified in the standards referred to in its documentation.

The content of the test procedure and the way in which the test results are presented are different according to the purpose of the control of the device:

i) Initial and periodical verifications

- in the case of completely configured and parameterized devices, all the implemented functions (non-programmable devices) are verified and a "pass/fail" result is formulated. A list of configurations and parameters must be enclosed with the verification document;
- in the case of initial verification, the same should be done. Further, a list of functions defined by the manufacturer shall be enclosed with the verification document.

ii) Type approval tests

Tests intended for type approval can be split into three categories:

- analysis of the existence of resources necessary for measurements that should be carried out by specific methods according to the standards;
- accuracy test under various operating conditions;
- test as to its resistance to different factors (climatic, mechanical, electric or electromagnetic disturbances).

Hardware and software resources constitute the most specific aspect of a flow computer. Verification of the existence of a resource aims at ascertaining whether the device is configurable so that it may fulfil the purposes prescribed by the normative documentation as well as those declared in the manufacturer's technical manual.

One of the *first* purposes refers to the hardware functions of the device and consists in:

- analysis of the input block performances so that the metrological performances of the device may be fulfilled under all operating conditions;
- analysis of output block functions, generally display devices that should be able to accurately display the main data (constants, variables, meter indications) existing in the computer at a given moment;
- analysis of hardware interfaces and devices designed to input data in order to identify communication types and capacities and their association with various internal modules with a view to the evaluation of the safe transfer of data;
- analysis of the safe operation of the micro computer system built into the flow computer under the operating conditions that the device is intended to fulfill.

The *second* purpose refers to the application program:

- a way of updating the variable parameter calculation method (calculated values, error limits, cycle duration, displayed values);
- program behavior when errors are signaled (during calculation, method restriction);
- interactions with the operator or with a master system (types of information, priorities).

Finally, the *third* purpose related to hardware and software resource analysis is the analysis of the configuration procedure:

- the ways of initiation or modification of configuration and access type;
- configuration means for alternative system structures and the effect on system performance;
- types and characteristics of configured variables;
- validation of configuration information.

Verification of flow computer accuracy consists in a series of operations intended to identify the errors defined in section 4 and whose limits are specified by the manufacturer's technical documentation or, generally, in a normative document (standard, OIML Recommendation) [12].

Verification of the input block accuracy shall be carried out in the same way as for verification of a voltage, current or frequency measuring device.

A signal applied to the respective input block of the computer is generated by a standard generator. The measured value is read and the error is calculated by the relation of (1) as a relative expression or with respect to the measuring range. Of course, the rules specific to every type of measurement will have to be applied.

Sometimes, computers cannot indicate electrical units (volts, amps, etc.), but rather units specific to physical quantities (Pa, bar, °C, etc.). In this case, the input value is converted into units specific to acquisition using the configuration data and so, errors are calculated by the same expression.

The global relative error of the computer, where the primary quantity is the flow, is determined as described below.

For a certain configuration, standard signal sources corresponding to all input quantities are connected to the computer. These sources are programmed to generate signals corresponding to a chosen operation point and the displayed flow rate is read. The global relative error ε is calculated by the relation:

$$\varepsilon = \frac{X - F}{F} \qquad (2)$$

where F is the conventional standard value of the flow rate and X is the measured value in the respective operation point.

The global relative error for the volume quantity often needs to be determined. In this case, for an operation point, as in the above experiment, the flow computer is allowed to integrate for a given time, t. If the volume indicated by the computer is V, then the error is calculated by the relation:

$$\varepsilon' = \frac{V - F \times t}{F \times t} \quad (3)$$

In the case where the computer functions as a volume corrector (converter), a similar calculation should be performed, except:

- the quantity whose global relative error is determined will be the correction coefficient (instead of the flow);
- the fluid volume measured by the computer is obtained by a pulse generator – a simulation of the meter.

In the case where the connection between the flow computer and the transducers is made by the interface, the principle procedure remains the same, the only difference is that another computer (usually a PC) fitted with the respective interface (where a specialized program for transducer simulation is installed) simulates the transducers. This program is developed by the manufacturer.

The experiments for global flow computer error determination generate many practical problems, particularly when new generation computers have input blocks fitted with 16-bit A/D converters and extended configurations (with a densitometer, for example). These problems are more severe when the device must be tested in a controlled environment.

A solution for improving the situation is based on the observation that the influences of climatic factors, mainly temperature, act by means of analogue input blocks; digital information processing is made without temperature-dependent errors (in the normal operation interval).

When the manufacturer declares error limits both for input blocks and for flow rate or correction coefficient, the following can be carried out:

- relative errors of input blocks are determined under all operating conditions (reference and normal);
- the global relative error is determined under the reference conditions;
- global uncertainty is established under reference and normal operating conditions using the determined errors of input blocks as input data.

The corresponding decision is adopted using the comparison of global uncertainty under normal operating conditions with an error limit for the respective quantity under the same conditions, as the manufacturer has indicated.

The global uncertainty estimation is achieved according to the provisions of the normative document referring to the measurement method [2]. When an estimation criterion cannot be specified, the confidence level of 95 % can be adopted.

The author considers it useful to mention the need to take into account first the reference conditions when at least a determined value of the global relative error exists and only then to proceed to normal operating conditions. The document formulated after the trial should contain explanations as to the calculation estimation as well as a description of the way in which the decision was formulated under the two operating conditions.

There are two situations in which the estimation of uncertainty under normal operating conditions is not necessary:

- error limits of analogue input blocks are the same under all operating conditions;
- a flow computer communicates via an interface with transducers (the information form transducers are directly and digitally sent).

As for the verification of different factors, now a series of metrological standards are in force [8, 9, 10] with respect to electronic meters similar to flow computers, having coherent provisions. The analysis of these documents and the trials carried out up to now show that adoption of document [9] as a reference is satisfactory for ascertaining the flow computer's resistance to different factors (climatic, mechanical, electric and electromagnetic disturbances).

6 Methods for testing the protection of information

Methods for protecting data in flow computers aim to safeguard this information for long time periods, sometimes exceeding one year.

External influences that can alter information are:

- power supply failure;
- electromagnetic disturbances;
- undesired access.

Protection in the case of power supply failure can be tested by comparison of configuration data and control indication before failure and after restoration. Power breakdown conditions and duration are chosen according to the data specified by the manufacturer.

Electromagnetic disturbances can influence the device's operation and, as a consequence, configuration information and content of the counters can be altered.

In order to test immunity to electromagnetic disturbances, the normative document [8] recommends a series of (satisfactory) methods for flow computers.

Protection against undesired access is particularly important in flow computer utilization and is closely connected with the activity of metrological verification.

It is obvious that access to the configuration function allows the alteration of configuration data and, in certain cases, changing of counter information is even possible.

Flow computer configuration can be achieved by:

- its own keyboard;
- an all-purpose or specialized terminal;
- an interface.

In the first two cases, access to the configuration function can be controlled by a switch located in a sealable slot.

In the third case, control means can be the same but the test of its action is more complicated as a computer may also have other interfaces which are differently configured.

It should be pointed out that security access provisions can be designed by the software developer in such a way as to restrict access to the configuration function by a certain interface.

In certain circumstances and due to the specific features of other equipment of the metering system – for example the computer for natural gas volume measurement – after passing to normal operation (sealing), a parameter set (defining gas composition and those related to it) can be modified by the master computer.

The configuration principle now used to formulate the flow computer application program allows not only access to a limited number of completely defined functions but to a series of parameters involved in the calculation algorithm.

Test methods described in this paper are specific to the category of application programs known as "firmware", always present in EPROM-type computer memories.

7 Examples

A flow computer such as CDN [12, 13], is delivered by the manufacturer together with the defined application (working environment, measuring method, main transducer type). Verifications carried out to obtain type approval included the configurable combinations that the definition allows. In the case of measuring natural gas volumes using an orifice plate the main configurable resources are:

- number of pressure difference transducers and their functions (active, control);

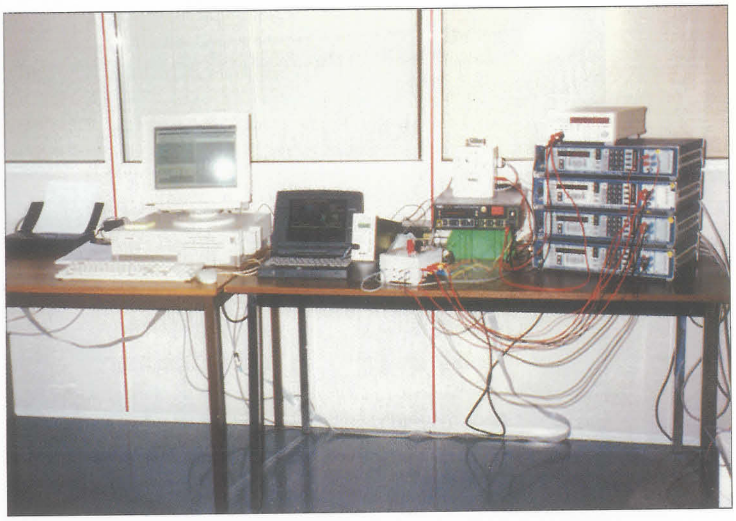


Fig. 1 Experimental set-up for testing of computers for gas volume measurement

- method to calculate the compressibility coefficient (NX 19, AGA 8, GERG 88, etc.);
- source of density values (measured, calculated);
- source of reference data - density, compressibility factor (calculated, fixed or inherent in the configuration);
- pressure measured by relative or absolute transducer.

It can be noticed that the number of combinations is high. Taking into account that every configured combination involves at least a program calculating the conventional true values, the experimental setup shown in Fig. 1 included two computers, a PC for flow computer configuration and operation and a laptop computer.

The setup used to verify CDN 12, a flow computer with a global relative error of 0.1 % in the case of gas volume measurement, shown in Fig. 1, also includes four highly accurate current generators (0.1 μA) and other devices.

To verify flow computers in the laboratory, all-purpose instruments are generally used.

It is practically impossible to achieve these conditions on the site where the flow computer is installed. More portable signal generators are necessary for this category of application.

The QI 21 flow computer [17] is a configurable device destined for water and steam volume measuring systems. Configuration is carried out by a specialized keyboard (see Fig. 2) and a laptop can also be used. The number of configurable combinations is lower (two differential pressure transducers, pressure measured by a relative or absolute transducer).

In order to verify this flow computer having a global relative error limit of 0.25 % on site, the manufacturer created a transportable four-module voltage and current generator, that can also be seen in Fig. 2 [17].

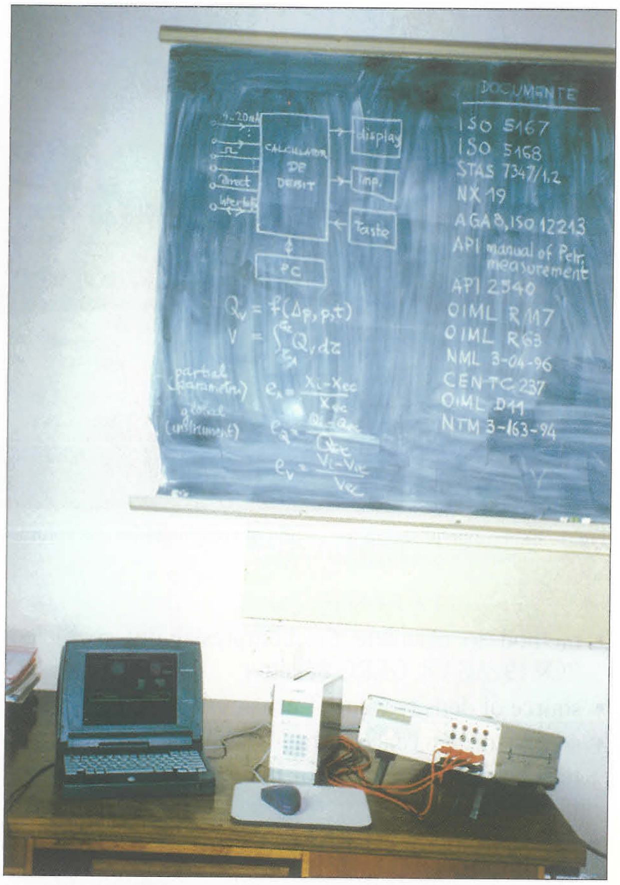


Fig. 2 Experimental set-up for testing configurable flow computers

8 Conclusions

This paper, drawn up as a result of experience gathered over many years, shows the main aspects involved in flow computer verification, some being general problems of electronic instruments provided by many normative documents that can be applied nowadays.

Taking into account the significant differences between the various types of flow computers and their wide range of applications, the paper only focused on common aspects of these devices, intending to outline in general the framework provided by the manufacturer.

Among the common matters, the multi-factorial experiments are highlighted in order to determine the global error of fluid volume or flow rate. The solutions given in the work are chosen according to practical criteria and include two ways of solving the problem based on electrical and digital simulation, both giving useful information for the evaluation of the metrological quality of the device.

These solutions are considered to be complementary. But what the optimum ratio of the amount of data obtained by the two ways of solving should be, is a question for which practice has not yet been able to provide an answer. ■

9 Bibliography

[1] ISO 5167: Measurement of fluid flow by means of pressure differential devices (1991)

[2] ISO 5168: Measurement of fluid flow. Estimation of uncertainty of a flow rate measurement (1978)

[3] STAS 7347: Metoda micsorarii locale a sectiunii de curgere. Masurarea cu diafragme si ajutaje. Metoda de calcul (1990)

[4] API: Manual of petroleum measurement. (1988)

[5] Petroleum measurement manual (John Wiley & Sons – 1987)

[6] AGA 8: Compressibility factors of natural gases and other hydrocarbon gases (1994)

[7] OIML R 63: Petroleum measurement tables (1994)

[8] OIML R 117: Measuring systems for liquids other than water (1995)

[9] OIML D 11: General requirements for electronic measuring instruments (1994)

[10] CEN TC 237/WG4/1995: Gas volume electronic conversion devices (draft standard, 1995)

[11] ASTM D 1250: Petroleum measurement tables vol. 7–10 (1980)

[12] NTM 3-163-94: Verificarea metrologica a sistemelor cu diafragma de masurare a cantitatilor de fuide si energie termica (1994)

[13] CDN 12:Bristol Meci s.a, Manuel d'utilisation

[14] SENTINEL 500: Spektra tek UK Ltd. Base gas orifice application manual

[15] Superflo II: Flow automation operation manual

[16] OMNI: Omni flow computers - Omni operator's manual

[17] QI – 21: QED (Quality Electronic Design) - Technical manual

The author welcomes comments and reactions to this paper, and can be contacted at the following e-mail address:

Ion Florian Cretu
ifc@cpcpub.sfos.ro

METROLOGY, EDUCATION AND TRAINING

Metrology education in a *Quality Engineering Undergraduate Study Program*

J. DRNOVŠEK, P.H. OSANNA, J. McGHEE, A. WECKENMANN, J. BOJKOVSKI and I. PUŠNIK

Abstract

A four-year undergraduate study program has been developed at the University of Ljubljana, Slovenia, in close cooperation with three other universities:

- *Vienna University of Technology, Austria,*
- *Strathclyde University, Glasgow, UK, and*
- *Erlangen-Nürnberg University, Germany,*

in order to provide a formal educational program for measurement/metrology related activities and quality, with the emphasis on metrology.

Metrology, measurement techniques and instrumentation science - all of which are fields related to quality production, quality services and other quality aspects - have to date mainly been taught in the context of other technical disciplines, but never as an integral study program. Some other institutions do, however, already provide various forms of basic metrology education/ training such as Brunell University in the UK, École Centrale (Lyon) and École des Mines (Saint-Etienne) in France, and the German Academy of Metrology, DAM.

This entire project (defining the curriculum, writing syllabuses, preparing relevant experiments, tutorials, etc.) has been supported by the EU in the framework of the Joint European Project JEP-TEMPUS 9886-95 project "Quality Engineering".

1 Introduction

The objective of the undergraduate study program (which started its first year in autumn 1997 at the University of Ljubljana) is to impart key knowledge in the form of a compact study program; this is especially pertinent for emerging new economies entering global markets.

In Europe, there is an additional requirement for deeper metrological knowledge since the implementation of European Directives actually starts with the metrology infrastructure, which is a prerequisite for testing, certification, conformity assessment and for actually implementing the various Directives as well as for applying worldwide technical agreements and standards.

The curriculum accommodates most of the needs of modern society, dealing with metrological problems in production, services and society itself. Special attention was paid to the content of course syllabuses in order to concentrate on key issues in measurement science and allow students to work creatively by carrying out as much practical and experimental work as possible. In the fourth year an industrial placement for students is included in order to strengthen ties with industry and universities as well as to prepare students for real-life working environments.

Much thought has also been given to the problem of how best to teach classical metrology topics such as traceability, uncertainty evaluation, error source analysis, error propagation etc., bearing in mind one clear, single goal: how can this extremely important subject (which is often considered as "complicated" or "unnecessary") be best put across to students. The partners in the project believe that there is a "user friendly" way to impart basic metrology concepts, which may be applied as one of the corner stones in ensuring quality production and quality services.

The program offers an undergraduate study program based on technical aspects of quality assurance techniques for quality products and services. Due to the fact that quality assurance (with the emphasis on technical aspects) depends largely on measurement related activities such as testing, standardization, data communication and data processing, the fields of electrical engineering and computer sciences fit most closely to the subjects. It is clear that managing quality systems is of equal importance; this is, however, covered only at the basic level.

The authors are convinced that understanding the technical aspects of quality requires a thorough, formal, theoretical and practical educational program, while managing skills could equally be mastered by other means. In addition new technologies, new production possibilities and (above all) new quality, safety and cost effectiveness standards etc. require adequate quality support. In this respect quality engineering could also be considered as being a key new scientific, academic and technological discipline, which would be justified in occupying a formal position within educational programs.

2 Structure of the Quality Engineering Undergraduate Study Program

First year

General program covering physics, mathematics, basic programming and basic electrical engineering.

Second year

Theory of measurement science and instrumentation, advanced electronics and microcomputing, modeling and simulation for systems analysis and identification, metrology and signal processing.

Third year

Quality management, statistical quality control, quality of software, sensors and actuators, testing and calibration, reliability and maintainability, innovations and industrial property plus selected modules: quality of health care systems and environmental monitoring, special measurement techniques and robotics, and quality of computer hardware and software.

Fourth year

The seventh semester is intended as an industrial placement period and the eighth for preparing a final diploma project. The former is an extremely important and very demanding part of the entire curriculum, necessitating a high degree of organization and efficiency but which enables students to work at higher levels; in return, host institutions are provided with skilled trainees.

Close cooperation has been established in participating countries with industry and national institutions responsible for metrology and standardization; these were also intensively involved in the preparation of the curriculum as well as in the organization of the program.

3 Development of the structure of the curriculum into four basic areas

The structure of the curriculum was developed according to the needs of industries and services which compete in common markets and which encounter current technological requirements as well as regulations regarding technical infrastructure. As a new program, no other constraints were imposed, but it was of utmost importance to cooperate with the former, thus ensuring the successful practical application of the course. At the beginning of the project four main areas of knowledge were identified and precisely defined; particular topics of these are listed below, followed by the detailed four-year timetable.

3.1 Basic theoretical knowledge

- Basics of electrical engineering;
- Mathematics;
- Physics;
- Basic programming;
- Analogue and digital electronics;
- Digital signal processing;
- Advanced programming and software techniques;
- Modeling and simulation;
- Microcontroller and microcomputer systems;
- Sensors and actuators;
- Control systems;
- Economics;
- Industrial property.

3.2 Metrology and instrumentation science

3.2.1 Metrology

- Legal metrology;
- Hierarchical structure of metrological systems;
- International compatibility;
- International metrology institutions and organizations;
- Theory of measurement science;
- Symbolic presentation of measurement results;
- Information content;
- Metrology in natural science and bio-social sciences;
- Modeling of measurement methods;
- Analysis of measurement errors and measurement uncertainties;

- Classification of measurement errors;
- Calibration;
- Standards;
- Fundamental and derived physical units;
- Physical constants;
- SI international system of units;
- Realization of units;
- Fundamentals of quantum metrology;
- Reference materials;
- Processing and evaluation of measurement results;
- Software for analysis of measurement results.

3.2.2 Instrumentation science

- Models of measuring systems and instruments;
- Influences and disturbances in measurements;
- Parameters of measurement systems (accuracy, resolution, stability and drift, uncertainty, etc.);
- Electrical measuring instruments (analogue);
- Registrators and bridges;
- Electronic measurement instruments (digital voltmeter, multimeter, differential voltmeter, wattmeter);
- Oscilloscope;
- Signal generator;
- Signal analyzer;
- Electronic counter;
- Transducers;
- Computer interfaces;
- Computer-controlled measurement systems;
- Standardized buses;
- Measurement system software;
- Virtual instrumentation.

3.3 Technical quality management

- Basic concepts of quality management;
- Quality costs and quality plans;
- Assessment of quality;
- Objectives and evaluation of quality;
- Quality improvement and cost reduction;
- Control of quality;
- Strategic quality management;
- Implementing total quality management;
- Organization for quality;
- Basic probability concepts;
- Statistical tools and methods for quality management;
- Design for quality;
- Statistical process control;
- Statistical control charts;
- Inspection test and measurement;
- Sampling plans;
- Information systems for quality;
- Quality assurance;
- Quality audit;
- Intelligent quality systems;
- Maintainability and reliability of components and systems;
- Artificial intelligence tools;
- Control chart pattern recognition;
- Integrated quality control systems;
- Condition-monitoring and fault diagnosis.

3.4 Standardization and conformity assessment

Assessment of conformity with standards can typically take a variety of forms and can vary from country to country depending on the prevailing techno-economic and social conditions and needs, but nevertheless general principles should be respected. Topics within the study program are therefore:

- Basic principles of standardization (industrial, national, international);
- ISO 9000 series, EN 45000 series, EN 14000 series;
- Product requirements and assessment of conformity;
- Conformity marking;
- Placing on the market and putting into use;
- Notification;
- Market surveillance;
- Organizations of accreditation schemes and certification systems;
- EU legislation and implementation of EU Directives.

3.5 Curriculum development

Details of the curriculum are given in the tables on the following page. Modules may be chosen as follows during the final year:

Module I: *1. Electrical safety in medicine*
2. Environmental monitoring

Module II: *3. Robotics and production engineering*
4. Development of specific test & measurement techniques (acoustics, electronic testing, visual quality inspection, etc.)

Module III: *5. Testing and certifying of computer hardware and software*
6. Quality of information systems

1st year

Course	1st semester			2nd semester		
	Lectures	Tutorials	Laboratory practice	Lectures	Tutorials	Laboratory practice
Basic Electrical Engineering I	4	2	2			
Mathematics I	3	4				
Physics I	3	3				
Basic Programming I	2	2				
Basic Electrical Engineering II				4	2	2
Mathematics II				4	3	
Physics II				3	3	
Basic Programming I				2	2	
Total hours: 50 (25 + 25)	**12**	**11**	**2**	**13**	**10**	**2**

2nd year

Course	3rd semester			4th semester		
	Lectures	Tutorials	Laboratory practice	Lectures	Tutorials	Laboratory practice
Measurements and instrumentation	3	0	4			
Electronics and digital techniques	3	0	4			
Modeling and simulation	3	0	3			
Software techniques	3	0	2			
Metrology				4	0	4
Control techniques				3	0	2
Microcomputers and microcontrollers				3	0	4
Signal processing				3	0	2
Total hours: 50 (25 + 25)	**12**	**0**	**13**	**13**	**0**	**12**

3rd year

Course	5th semester			6th semester		
	Lectures	Tutorials	Laboratory practice	Lectures	Tutorials	Laboratory practice
Quality management I	4	0	4			
Statistical quality control	2	0	3			
Quality of software	3	0	3			
Sensors and actuators	3	0	3			
Testing and calibration of electrotechnical equipment				3	0	3
Reliability and maintainability of components and systems				2	0	3
Innovations and industrial property				2	0	0
Quality management II				2	0	2
Individual selection of modules				4	0	4
Total hours: 50 (25 + 25)	**12**	**0**	**13**	**13**	**0**	**12**

4th year

Course	7th semester	8th semester
	Industrial placement	Diploma work

4 Concluding remarks

The final version of the Quality Engineering curriculum has been prepared with the aim of achieving optimal teaching and studying results in quality and measurement related activities. In implementing the program, some specific requirements regarding Slovenian higher education rules were taken into account, as they would have to be in any other country if a similar course was instigated. Besides the main objectives such as course syllabuses, much emphasis was also put on how to teach classical metrological, test and measurement and quality topics in such a way as to attract students' attention. Special care was also taken in the choice of tutorials, experiments, teaching materials, etc.

Joint development of this study program proved to be an extremely interesting academic exercise; moreover the investigation of other social implications such as employment possibilities, industrial needs, etc. proved to be of equal importance. It has to be emphasized that the whole philosophy behind the entire project in terms of justifying it, providing expertise, generating new ideas, was to a large extent due to the authors' active participation in such international organizations as IMEKO (*International Measurement Konfederation*), OIML (*Organisation Internationale de Métrologie Légale*), EOQ (*European Organization for Quality*), EUROMET (*European Collaboration in Measurement Standards*), and some others.

The most interesting part of the project still has to be seen, namely the interest of students in choosing the Quality Engineering study program, and at later stage their employment possibilities and professional successes. ■

Contact addresses:

J. Drnovšek, J. Bojkovski and I. Pušnik
University of Ljubljana,
Faculty of Electrical Engineering,
Laboratory of Metrology and Quality Control,
Tržaška 25, 1000 Ljubljana, Slovenia
Tel: +386 61 1768 223
Fax: +386 61 1264 633
E-mail: janko.drnovsek@fe.uni-lj.si

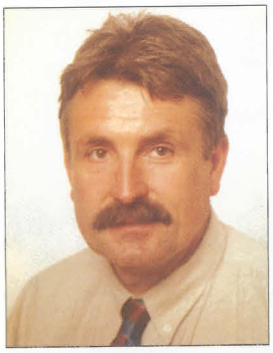
P.H. Osanna
Technische Universität Wien,
Institut für Fertigungstechnik,
Abteilung Austauschbau und Meßtechnik,
Karlsplatz 13, 1040 Wien 4, Austria
Tel: +43 222 588 01/3189
E-mail: osanna@eftuv1.tuwien.ac.at

J. McGhee
Strathclyde University,
Department of Electronic and Electrical Engineering,
Industrial Control Centre,
Glasgow G1 1QE, UK
Tel: +44 141 548 4206
Fax: +44 141 548 4203
E-mail: joe@icu.strath.ac.uk

A. Weckenmann
Universität Erlangen-Nürnberg, Lehrstuhl für Qualitätsmanagement und Fertigungmesstechnik,
Nägelsbachstraße 25,
D-91052 Erlangen, Germany
Tel: +49 9131 852 6520
Fax: +49 9131 852 6524
Email: weckenmann@qfm.uni-erlangen.de

Acknowledgement

Special thanks to the Faculty of Electrical Engineering, University of Ljubljana, Slovenia and to the Standards and Metrology Institute of the Republic of Slovenia (SMIS) for their support, encouragement and promotion of metrology and technical quality education.



J. Drnovšek

P.H. Osanna

J. McGhee

A. Weckenmann

EXPERIENCES OF A SECONDMENT SCHEME

SEMAT: a Technology Partnership Programme

HILARY McNEILL, National Physical Laboratory, Teddington, United Kingdom

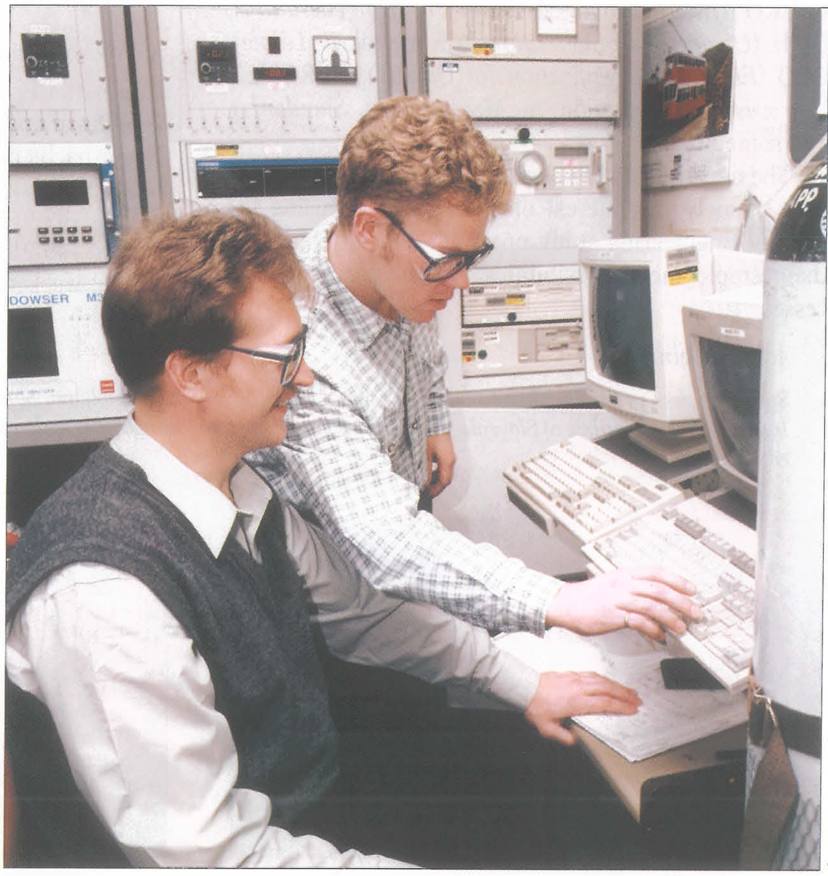
Introduction

The SEMAT (*Secondment in European Measurement and Testing*) Programme fosters links with selected Central and Eastern European countries by providing partial support of the costs of hosting a small number of young, highly qualified and experienced Central and Eastern European scientists for up to six months in UK organisations. The aim of SEMAT is to reduce technical barriers to trade between the UK and Central and Eastern Europe and to promote trade and collaboration by fostering strong personal and corporate links between the UK and the partner countries. As a result of their placement, the secondees become aware of what the UK offers in the fields of metrology, standards, testing and quality; they also go on to develop longer-lasting partnerships with UK organisations that can be sustained without further UK Government assistance.

Background

Since the political changes in the late 1980's, Central and Eastern European countries have begun to industrialise rapidly and are now looking to form strategic and commercial alliances with Western countries in many areas of scientific, economic and cultural activity. Many are now negotiating accession to the EU and are having to tackle the reduction of technical barriers to trade, adoption of EU Directives and the shift from a standards environment dominated by legal (rather than scientific) metrology. This presents challenges for them and at the same time creates opportunities for the UK to provide assistance and thereby improve trade links.

The field of metrology, standards, testing and quality (MSTQ) is one in which the UK has well-developed capabilities and is internationally respected. This therefore puts us in a strong position to offer help, and to provide opportunities



Janusz Indulski of the Central Office of Measures, Warsaw at work with Dr. Paul Holland in NPL's Environmental Standards Section for Central and Eastern European scientists to share knowledge and technology transfer activities with UK partners.

The SEMAT Programme was conceived as a means of reducing technical barriers to trade between the UK and Central and Eastern Europe. Trade and collaboration can be encouraged and promoted by fostering strong personal and company links between the UK and the partner countries. This is achieved by providing partial support of the costs of hosting a small number of young, highly qualified Central and Eastern European scientists for up to six months in UK laboratories and companies.

The National Physical Laboratory (NPL) carried out a feasibility study on behalf of the UK Government's Department of Trade and Industry (DTI) which was completed in March 1997. This study identified the four Central European countries with which the SEMAT Programme would be started: Czech Republic, Hungary, Poland and Slovakia. Two other countries, Slovenia and Ukraine, were also identified as second phase countries, to be brought into the Programme during its second year.

The Scheme

The SEMAT secretariat was established at NPL on behalf of the DTI in June 1997. We have identified a SEMAT "country coordinator" for each of the partner countries to act as our contact point in their country. This is a high profile scientist who, through his or her contacts, is able to draw the attention of organisations and individuals to the SEMAT Programme using our promotional brochures.

The country coordinator sorts through the applications, ensuring the suitability of the applicants, before passing them on to the UK secretariat.

Once the SEMAT Secretariat receives the applications, we endeavour to identify a suitable UK laboratory to act as the host laboratory for the secondment. Placements are made at United Kingdom Accreditation Service (UKAS) accredited laboratories with a similar background and work area as those of the applicant's organisation. All areas of measurement and testing are covered from high level metrology to environmental chemical analysis as well as product testing.

When convenient dates for the secondment are agreed on between the secondee, his or her employer and the host organisation, the SEMAT secretariat arranges and pays for travel to the UK for the secondee. The host organisation is responsible for arranging and covering the costs of accommodation for the secondee. In addition, the host provides a small living expenses allowance for the duration of the placement and the secondee's employer must commit to paying the secondee's usual salary during the secondment.

It is the intention that a SEMAT secondment should not represent a financial burden to the individual concerned.

Support

The SEMAT Programme has received considerable support from UK industry. One manifestation of this is the support that has been received from UK City of London Livery Companies. The Worshipful Company of Scientific Instrument Makers, The Company of Water Conservators and the Worshipful Company of Information Technologists have all added their name to the scheme. In addition, they offer bursaries and commemorative certificates to secondees working in appropriate fields. These are presented by the Companies at suitable events during the course and all secondees completing a 6-month placement in the UK receive such a bursary from one of the sponsoring Companies.

This gives an indication of the degree of success and enthusiasm there is for the SEMAT Programme within UK industry.

Progress

The first wave of secondees from the first-phase partner countries, Czech Republic, Hungary, Poland and Slovakia, started their placements in October 1997. Numerous curriculum vitae and applications have been received by the SEMAT secretariat via the coordinators. The SEMAT scheme has placed 11 scientists at UK laboratories, five of whom have been at NPL itself.

Negotiations are under way with the second-phase partner countries, Slovenia and Ukraine. Country coordinators have been agreed on and the first SEMAT secondees from these countries will come to the UK during 1999.

Experiences

NPL

To date, NPL has hosted SEMAT secondees in the following fields:

- coordinate measuring machines;
- optical radiometry;
- environmental standards;
- materials metrology; and
- mass and density.

The experiences have generally been favourable; NPL has benefited from the input of highly qualified expert scientists, learned techniques used by a different national metrology institute and has gained from a two-way exchange of ideas and experiences.

The secondees have informed the SEMAT secretariat that they have particularly benefited from the use of different techniques and the calculation and consideration of uncertainty. However, the main benefit, as reported by the secondees and host, is the formation of close personal contact with metrologists working in the same field.

Other Placements

These placements have so far been in the environmental sector, specifically testing laboratories of the UK water industry. Areas of secondments have been the organic analysis of drinking water and the analysis of sludge and solids.

Again, experiences have been good with the secondees particularly benefiting from the exposure to the latest technology and equipment. The major benefit as reported by the secondees has been the opportunity to exchange ideas and experiences with UK scientists working in the same field.

Directly as a result of hosting a SEMAT secondee, one UK water company has gained the opportunity to provide quotations for a series of sophisticated analyses for a laboratory in the Czech Republic. This is an example of one of the ways we envisage the close relations between the host and parent organisation leading to improved trade in the future.

Summary

The SEMAT secondment scheme is a new scheme funded by the UK Government's Department of Trade and Industry and managed by NPL under NPL's Global Metrology Initiative. The aims of the scheme are to increase knowledge transfer between scientists and technologists in the UK and selected Central and Eastern European countries and, as a result, to reduce trade barriers and increase cooperation and trade in the future.

The secondments which have taken place so far have been very successful with much good quality knowledge transfer taking place in both directions. Close professional relationships are developing which are already leading to increased cooperation and trade between the UK and the partner countries. ■

For more information, contact:

Hilary McNeill

National Physical Laboratory
Queens Road
Teddington
Middlesex TW11 0LW
United Kingdom

Tel: +44 181 943 6736
Fax: +44 181 943 6082
E-mail: hilary.mcneill@npl.co.uk

Reproduced by kind permission of Gerald Sharpe Photographers

Edit Banreti of the National Office of Measures, Budapest receives her Bursary and Certificate from Sir Ivor Cohen, CBE, Master of the Worshipful Company of Scientific Instrument Makers

Reproduced by kind permission of the Company of Water Conservators

Dana Vaclavicova of ECOCHEM, Prague receives her Bursary and Certificate from Mr. Bruce Hewett, Master of the Company of Water Conservators

METROLOGICAL INFRASTRUCTURES

Legal metrology in Algeria
La Métrologie Légale en Algérie

N. HAMIHAM, Office National de Métrologie Légale, Alger, Algeria

1 Historique

La pratique de la métrologie légale en Algérie existe depuis 1962 sous les appellations suivantes: de 1962 à 1969: *Service des Poids et Mesures;* de 1970 à 1986: *Service des Instruments de Mesure* et de 1986 à ce jour: *Office National de Métrologie Légale.*

2 Attributions

Pour l'exercice de cette activité l'Office National de Métrologie Légale, établissement public à caractère administratif, a été créé par décret n° 250-86 du 30 septembre 1986. Il est doté d'une indépendance morale et d'une autonomie financière.

Dans le domaine des instruments de mesure, l'ONML procède aux études et aux essais des nouveaux modèles en vue de leur approbation et effectue les vérifications primitive et périodique des instruments utilisés dans le commerce et l'industrie. Il est également chargé d'effectuer des opérations de revérification des étalons et des opérations d'étalonnage de précision des instruments de mesure et de pratiquer une surveillance permettant de constater que ces instruments répondent aux prescriptions légales.

Par exemple, il effectue des travaux de jaugeage et de barèmage de cuves de chais, de cuves de navires, des réservoirs fixés, de camions-citernes, de wagons-citernes servant au transport et à l'entreposage des hydrocarbures, vins, alcools, etc.

Il doit aussi s'assurer que les unités utilisées correspondent bien aux définitions établies par le système international d'unités SI.

En collaboration avec les constructeurs, l'ONML participe à la conception des instruments de mesure afin de faire respecter les normes de construction (précision, fiabilité, robustesse...), ainsi que la réglementation technique.

Il participe enfin à l'élaboration de la réglementation technique à laquelle doivent satisfaire les instruments, tant au niveau de leur fabrication, de leur utilisation que de leur contrôle.

1 History

Legal metrology has existed in Algeria since 1962 under the following successive designations: from 1962 to 1969: *Weights and Measures Service;* from 1970 to 1986: *Measuring Instruments Service* and from 1986 to now: *National Office of Legal Metrology.*

2 Scope

The National Office of Legal Metrology is a financially autonomous public sector institution of an administrative nature created by decree n° 250-86 (1986.09.30) that has moral independence for carrying out legal metrology activities.

In the field of measuring instruments, the ONML conducts evaluations and tests on new models with a view to their approval. It also carries out initial and subsequent verifications of instruments used in trade and industry. Further, the ONML is responsible for performing reverifications of standards and precision calibration operations of measuring instruments and controls whether these instruments meet legal regulations.

For example, it carries out gauging and scaling of wine vats, ships' tanks, fixed storage tanks, tanker lorries, and rail tanker wagons used for transporting and for stocking hydrocarbons, wines, alcohol, etc.

The ONML also ensures that units employed actually correspond to the definitions laid down by the SI international system of units.

In association with manufacturers, the ONML participates in the design of measuring instruments so that the latter are manufactured in accordance with requirements for accuracy, reliability, sturdiness, etc., as well as technical regulations.

It also participates in the elaboration of technical regulations with which instruments must comply regarding manufacturing, utilization and subsequent control.

Sur le plan de l'infrastructure son rôle consiste à créer et mettre en place des laboratoires de métrologie, des centres techniques spécialisés devant servir aux travaux de recherches métrologiques, d'études et de contrôles.

Il centralise, traite et met à la disposition des opérateurs nationaux, l'ensemble des informations scientifiques et techniques relatives aux instruments de mesure et constitue une banque de données relatives aux constructeurs afin d'aider les opérateurs nationaux dans leur choix et leur utilisation des équipements.

Au niveau national il participe à la promotion de la métrologie par l'organisation et l'animation de conférences, d'expositions et de séminaires ainsi que par la rédaction et la publication de revues spécialisées, l'échange d'expériences et de voyages d'études. Sur le plan international il est de son ressort de participer aux activités liées à la métrologie et de développer les relations avec les organismes internationaux.

Enfin dans le domaine de la formation, il propose des mesures susceptibles de réaliser une meilleure coordination des actions de formation de personnel spécialisé en métrologie.

3 Organisation administrative

Pour accomplir ses missions, l'Office est composé de trois Départements dont deux techniques, quatre Annexes Régionales et 48 Antennes de Wilaya.

4 Moyens de vérification

L'Office dispose de l'appareillage suivant:

- une série de poids de la classe M_1: 10 kg à 500 g - (18,5 kg) - 500 g à 1 mg - (1 kg);
- une série de poids étalons (année 1936): 1 kg à 1 g (1 920 g);
- des masses de travail de 20 kg;
- un mètre étalon (comparateur modèle 1931) - 1 mètre à dilatation réelle à 20 °C de – 0,0102 % par mètre et par degré;
- des mesures de 5 L, 10 L, 20 L, 100 L, 500 L et 1 000 L;
- des instruments de vérification pour réservoirs de stockage;
- des camions étalons pour contrôle des ponts bascules (portée maximum: 8 t en masses de 500 kg).

5 Dispositif législatif et réglementaire

Liste des lois et décrets constitutifs de la métrologie en Algérie:

- Loi n° 90-18 du 31 juillet 1990 relative au système national légal de métrologie;

As far as the infrastructure is concerned, the ONML's role consists in creating and setting up metrological laboratories, specialized technical centers to be used for metrological research work, studies and controls.

It centralizes, processes and makes available to national operators an entire range of scientific and technical information relating to measuring instruments and maintains a database of manufacturers in order to help national operators in their selection and use of equipment.

At national level it helps to promote metrology by organizing conferences, exhibitions and seminars as well as by editing and publishing specialized reviews, exchanging experiences and organizing study trips. At the international level the ONML is to participate in metrology-related activities and develops relations with international organisms.

Concerning training, it proposes measures likely to achieve a better coordination of training of specialized metrology personnel.

3 Administrative organization

To accomplish its missions, the Office is composed of three Departments (of which two are technical), four Regional Annexes and 48 Wilaya Antennae.

4 Verification means

The Office has the following equipment at its disposal:

- a series of class M_1 weights: 10 kg to 500 g - (18.5 kg) - 500 g to 1 mg - (1 kg);
- a series of standard weights (year 1936): 1 kg to 1 g (1 920 g);
- working masses of 20 kg;
- a standard meter (comparator model 1931) - 1 meter with true dilation at 20 °C of – 0.0102 % by meter and by degree;
- liquid measures of 5 L, 10 L, 20 L, 100 L, 500 L and 1 000 L;
- instruments for verifying storage tanks;
- weight trucks for the control of weighbridges (maximum capacity: 8 t of 500 kg masses).

5 Legislative and statutory aspects

List of laws and decrees constituting metrology in Algeria:

- Law n° 90-18 dated 1990.07.31 relating to the national legal system of metrology;

- Décret n° 86-250 de septembre 1986 créant l'Office National de Métrologie Légale.

Décrets exécutifs du 25 décembre 1991:

- n° 91-537 relatif au système national de mesure;
- n° 91-538 relatif au contrôle et aux vérifications de conformité des instruments de mesure;
- n° 91-539 fixant les catégories de fonctionnaires et d'agents habilités à constater les infractions à la loi relative au système national légal de métrologie.

Arrêtés du 15 juin 1992:

- conditions de fabrication des mesures de masses;
- conditions d'agrément des installateurs et réparateurs d'instruments de mesure;
- conditions d'approbation et de dépôt de modèles d'instruments de mesure;
- dispositions applicables aux: instruments de pesage, compteurs d'eau froide, compteurs horokilométriques (taximètres), ensembles de mesurage pour liquides autres que l'eau, compteurs de volume de gaz, camions citernes destinées au transport des hydrocarbures, compteurs d'énergie électrique.

Arrêté du 4 septembre 1996:

- institution de la journée nationale de la Métrologie.

Arrêtés du 24 septembre 1996:

- prescriptions techniques et métrologiques applicables aux indicateurs de niveau des liquides dans les réservoirs de stockage;
- dispositions techniques et métrologiques applicables aux instruments de mesure de longueur;
- prescriptions générales applicables aux réservoirs de stockage fixe.

6 Résultats obtenus

Outre le contrôle des instruments de pesage classiques destinés aux transactions commerciales, l'ONML a élargi son champ de contrôle aux instruments de mesure suivants:

- compteurs d'énergie électrique mono et triphasés;
- compteurs d'eau;
- compteurs de gaz;
- débitmètres sur gazoduc et oléoduc;
- thermomètres médicaux;
- tubes étalons;
- taximètres;
- avitailleurs;
- camions citernes destinés au transport des hydrocarbures;
- réservoirs de stockage;
- distributeurs de carburants.

- Decree n° 86-250 of September 1986 creating the National Office of Legal Metrology.

Executive decrees dated 1991.12.25:

- n° 91-537 relating to the national measurement system;
- n° 91-538 relating to the control and conformity verifications of measuring instruments;
- n° 91-539 fixing the categories of civil servants and officers who are entitled to pronounce an infringement of the law relating to the national legal system of metrology.

Orders of 1992.06.15:

- manufacturing conditions for mass measures;
- conditions for acceptance of service agents for installation and repair of measuring instruments;
- conditions for approval of measuring instruments and for patent requests;
- provisions applicable to: weighing instruments, cold water meters, horokilometric meters (taximeters), measuring equipment for liquids other than water, gas volume meters, tankers for the transportation of hydrocarbons, electrical energy meters.

Order of 1996.09.04:

- Introduction of National Metrology day.

Orders of 1996.09.24:

- technical and metrological provisions applicable to level gauges for liquid in storage tanks;
- technical and metrological provisions applicable to instruments for measuring length;
- general prescriptions applicable to fixed storage tanks.

6 Results obtained

Besides controlling classical weighing instruments destined for commercial transactions, the ONML has broadened its scope of control to the following measuring instruments:

- mono- and tri-phased electrical energy meters;
- water meters;
- gas meters;
- flow meters on gas mains and pipelines;
- clinical thermometers;
- pipe provers;
- taximeters;
- refuellers;
- tankers destined for transportation of hydrocarbons;
- storage tanks;
- fuel dispensers.

Compte tenu de ces nouvelles responsabilités et de l'inadéquation des moyens mis en oeuvre, les résultats enregistrés restent limités voir peu satisfaisants.

7 Conclusion

Conformément à la réglementation en vigueur, l'ONML a pour objet de participer à la sauvegarde de la garantie publique et à la protection de l'économie nationale sur le plan des échanges nationaux et internationaux et de contribuer à la réalisation des objectifs inscrits dans les plans nationaux et programmes de développement métrologiques.

Malheureusement, depuis sa création en 1986, l'ONML n'a été doté d'aucun équipement de contrôle et d'étalonnage supplémentaire afin de répondre aux besoins croissants formulés par les opérateurs économiques nationaux. De même, l'ONML ne dispose à ce jour d'aucun laboratoire d'étalonnage ni d'étalons nationaux retraçables aux étalons internationaux - pourtant indispensables pour assurer la fiabilité de la mesure en Algérie.

De plus, la formation de personnel technique qualifié est l'une des faiblesses enregistrées par l'ONML; la mise en oeuvre d'un programme de formation de métrologie n'a pu être concrétisée.

L'ONML se trouve dans une situation où le travail est abondant mais les fonds sont insuffisants. Ce problème n'est pas spécifique à l'Algérie puisque de nombreux, sinon la plupart des pays, connaissent le même sort. C'est pourquoi la collaboration internationale en vue de promouvoir les activités de la métrologie légale est peut-être le moyen globalement le plus efficient et le plus efficace pour aborder ce problème. Aussi, la concrétisation de cette collaboration devrait être un objectif prioritaire et permanent pour l'OIML.

En développant des mécanismes qui aideraient les Membres de l'OIML à asseoir des relations bilatérales concrètes, l'OIML contribuerait grandement à la satisfaction des besoins croissants de la métrologie légale.

Par ailleurs, la sensibilisation des gouvernements sur l'impact de la métrologie légale dans le développement économique et social des pays est également un paramètre que l'OIML devra prendre en charge en multipliant des actions concrètes dans ce sens.

En Algérie, il est à préciser que la sensibilisation dans ce domaine par le gouvernement est célébrée officiellement lors de la Journée Nationale de la Métrologie le 30 septembre de chaque année.

Sous le thème *"La métrologie au service de l'économie nationale"*, cette Journée (qui a regroupé environ 150 participants) a été inaugurée par le Ministre de l'Industrie et de la Restructuration et le Ministre de la PME et PMI. ■

Considering these new responsibilities and the inadequacy of the means available, the results recorded are limited, if not unsatisfactory.

7 Conclusion

In accordance with current legislation, the ONML's mission is to contribute to consumer confidence and protection of the national economy as a whole by regulating national and international exchanges of trade, and to contribute to the attainment of objectives set out in national programs for metrological development.

Unfortunately, since its creation in 1986, the ONML has not been provided with any additional checking and calibration equipment to meet the growing needs expressed by national economic operators. Moreover, the ONML does not have at its disposal any calibration laboratories nor any national standards traceable to international standards – even though these are indispensable to ensure the reliability of measurements in Algeria.

In addition, the training of qualified technical personnel is one of the weaknesses noted by the ONML; the establishment of a metrology training program could not be accomplished.

The ONML is in a situation where work is abundant but funds are insufficient. This problem is not specific to Algeria as many, if not most, countries are in the same position. Therefore, international collaboration towards the promotion of legal metrology activities may be the most globally efficient and effective way to address this issue. Concretising this type of collaboration should therefore be a permanent priority objective for the OIML.

By developing mechanisms which would help OIML Members to establish concrete bilateral relations, the OIML would greatly contribute to satisfying the growing needs of legal metrology.

Moreover, making governments aware of the impact of legal metrology in countries' economic and social development is also a role that the OIML must take on, by multiplying concrete actions in this direction.

In Algeria, it should be highlighted that the government strives to increase awareness in this field by celebrating National Metrology Day every year on 30th September.

Based on the theme *"Metrology at the service of the national economy"*, this Day (which was attended by some 150 participants) was inaugurated by the Minister for Industry and Restrucuring and by the Minister for Small Businesses. ■

33rd Meeting of the International Committee of Legal Metrology

CIML Seoul 33rd Meeting

Seoul, Republic of Korea 28–30 October 1998

Introduction to the Republic of Korea

The Republic of Korea is a part of the Korean Peninsula which extends southward from the eastern end of the Asian continent and which is roughly 1 000 km long and 216 km wide at its narrowest point. Mountains cover 70 % of the land area, making the peninsula one of the most mountainous regions in the world.

The Republic of Korea's 99 268 km² is populated by some 44 million people and consists of 9 provinces, one special city (Seoul) and the 6 metropolitan cities of Pusan, Taegu, Inch'ŏn, Kwangju, Taejŏn and Ulsan.

In total, there are 71 cities and 94 counties in the 9 provinces. Gross national product is $480.4 billion ($10 548 per capita income). Seoul is both the capital and the heart of the Republic of Korea, containing about 10.2 million inhabitants, and is its financial, political, commercial, recreational, educational and cultural center.

The OIML Development Council Meeting and 33rd CIML Meeting were held from Wednesday 28 through Friday 30 October 1998 at the Radisson Plaza Hotel in the heart of Seoul. Below is a full account of these meetings. ■

OIML Development Council Meeting – Wednesday 28 October 1998

The OIML Development Council met in Seoul prior to the 33rd CIML Meeting; 30 Member States and five Corresponding Members were represented by sixty-one delegates including Mr. Birkeland (CIML Immediate Past President) and three members of BIML staff.

In his opening remarks Mr. Faber, CIML President, explained the present situation and referred to his request made in Rio to Mr. Kochsiek (CIML Vice-president) to continue to occupy the role of Acting Chairman until (and including) this meeting.

After the roll call of delegates the agenda was approved as proposed.

Item 1 Report on activities since the 1997 meeting of the Development Council

Members of the Council were reminded of 1998's transitional character and the following two items of the report were pointed out by Mr. Szilvássy (BIML):

- the June Braunschweig Seminar was a good opportunity to meet representatives of other institutions/organizations and highlighted the problems of developing countries, especially those of the least developed ones;
- two summary documents produced by the BIML to facilitate further activities of the Council had been compiled and distributed.

Item 2 Reports of the Working Groups' Chairpersons

Mr. Wallerus (DAM, Germany), Convenor of WG 1 on *Training*, gave a transparency presentation on building up a training and qualification system based on a modular approach which can be used in any country, and also distributed a written report.

Mr. Magana (France) stressed the importance of extending the scope of training to industrial metrology. Mr. Birch (Australia) pointed out the necessity for policy and managerial training and the need for authorities to commit to funding equipment after training. Ms. Marston (Australia) proposed international cooperation in order to harmonize the existing training programs and Mr. Issaev (Russia) suggested the creation of an OIML system of certification of personnel in legal metrology.

In a report given on behalf of Mr. Okrepilov (Russia), convenor of WG 3 on *Planning and equipment of legal metrology laboratories*, Mr. Issaev pointed out the necessity for a revision of several OIML Publications on planning and equipment of legal metrology laboratories (P 4, P 6, P 7) and of the International Document on *Training of legal metrology personnel* (D 14) which were developed some 10–15 years ago.

WG 3 has already started revising the publication on *Planning of metrology and testing laboratories* on the base of recent ISO Standards. A written proposal on further revisions will be prepared and distributed later on.

A further point was made on the necessity to restructure the Working Groups' scope of activity, taking into account the need for a metrological infrastructure for assurance of quality control and support of conformity assessment.

Item 3 Report on the June 1998 Braunschweig Seminar

In a detailed report, Mr. Kochsiek underlined that the focal point of interest was the special challenge arising from the increasing globalization of economic activities.

The Seminar was the first of its kind to give a comprehensive survey of numerous aspects of metrology, with contributions from a large and representative audience of specialists. Lecturers from international, regional and national organizations and from private enterprises contributed their knowledge and experience, presenting a wide range of facts and ideas. To ensure that all this information can be fully utilized, the proceedings will be published by the PTB (scheduled for December 1998).

The personal contacts established during the Seminar will be valuable for the future exchange of ideas and experience; both the organizers and the participants must concentrate on the implementation of the measures found to be necessary.

Item 4 Reports of representatives of Regional Legal Metrology Organizations

Mr. Birch, APLMF Convener, reported on the activities of the Forum and the results of its meeting held in Seoul over the previous two days. He underlined that the programs of the Forum and of the Development Council should be complementary and that the results and experience of the Forum, particularly in the fields of harmonizing training programs, modernization of administrative and legislative infrastructures and raising the profile of legal metrology, can be utilized in Development Council activities.

Mr. Issaev gave a short report on recent COOMET activities and drew attention to the account of its 8th Committee Meeting, published in the October 1998 OIML Bulletin.

Mr. Birch reported on the establishment in March 1998 of the *Indian Ocean Legal Metrology Forum (IOLMF)* with the participation of 12 countries and on its first activities including the creation of a legal metrology directory, organization of a workshop on legal metrology issues (November 1998, Sri Lanka) and development of a work program for the next year.

Mr. Beard (South Africa), representative of the South African Development Community Legal Metrology Cooperation (SADCMEL, formerly SALMEC) outlined the structure, aims and work program of the organization. He mentioned that training and capacity-building are regarded as high priority and that a Regional Resource Center for Metrology Education will soon be established. He also mentioned that funding and assistance are needed for training legal metrology personnel and for assisting the least developed Member States in developing their legal metrology infrastructures.

Mr. Guimaraes (Brazil) gave a short report for SIM and mentioned that a working group on legal metrology has been created with the aim of helping small Member States in the Caribbean Area in establishing and/or developing their legal metrology infrastructures.

Mr. Chappel (USA) gave information on the Workshop on legal metrology issues organized by NIST, SIM and the OIML in June 1998.

OIML Development Council panel (left to right):
B. Athané, G. Faber, M. Kochsiek and A. Szilvássy

Mr. Bennett, Chairman of WELMEC, gave a brief description of activities and pointed out that besides the 18 full Members (EU and EFTA countries) the organization has 8 Associate Members from Central and Eastern European countries in transition towards a market economy.

Further he agreed with the proposal that there is a need to gather information in Europe and harmonize the existing training programs.

Mr. Zhagora (Belarus) reminded Council Members that:

- a report on the activities of the Interstate Council for Standardization, Metrology and Certification of the CIS countries was published in the October 1998 OIML Bulletin;
- a model law on metrological assurance of measurements had been developed; and
- a proposal for cooperation between the OIML and the Interstate Council was being developed.

Item 5 Guidelines for future activities

The BIML produced and distributed two Development Council summary documents:

- Main Issues 1968–1998, and
- Guidelines for the future activities in 1999–2000: Considerations,

with the aim of assisting the Council (especially its new Members) in preparing its future work program. The first paper summarizes the last 30 years of policies and concerns relating to the Council, while the second one groups together the most important issues from the point of view of policy and strategy, laws and infrastructure, funding, training and general activities and gives a summary of the main recommendations.

Mr. Birkeland first explained his preliminary research objectives and then summarized his key Study suggestions for the Council as follows:

- there is an urgent need to revise OIML D 1 *Law on Metrology* on the part of developing countries that wish to introduce new coherent legal metrology legislation and the Council should actively participate in this revision;
- it is necessary to enhance the effectiveness of cooperation between OIML and regional legal metrology bodies in order to promote metrology development in fields of common interest. Establishment of a joint committee under OIML leadership with the active participation of the Council would be an appropriate framework for this cooperation;
- high priority should be given to the training of national staff;
- it is very important to prepare studies on the economic and social impact of changes in legal metrology infrastructure, and
- there is an ongoing need to systematically develop multinational agreements on mutual acceptance of results and/or certificates of several kinds of conformity assessments, including OIML certificates.

Mr. Kochsiek explained that the proposal for the 1999–2000 work program prepared by the BIML was based on the outcome of the Seminar, on the two summary papers produced by the BIML and on the key suggestions of the Birkeland Study. His intention is that the new Chairperson of the Council together with the BIML develop a detailed work program with the possible inclusion of further actions based on proposals to be received from the Members of the Council.

Mr. Birch proposed two actions to be included in the work program:

- organization of a seminar on modernization of legislative and administrative systems of legal metrology, and
- consideration of international accreditation of legal metrology training courses.

Item 6 Special items

Concerning the participation of Corresponding Members in Development Council activities, Mr. Athané (BIML) explained that they are usually invited to participate in Council meetings and the proposal aimed at increasing their participation in certain OIML activities will be discussed during the 33rd CIML Meeting.

Mr. Kochsiek informed the Council that due to its broad previous experience, the PTB had received two proposals: one from UNIDO waiting for projects for the least developed countries and the other from the European Union for projects for the developing North African countries of the Mediterranean Region. In both cases a fund of US$ 1 million is available.

The PTB is willing to start these projects off but needs the assistance of OIML Members in order to ensure a wider cooperative base.

Item 7 Election of a Development Council Chairperson

Mr. Kochsiek gave information on the inquiry among CIML Members for candidates and on contacts with several possible candidates. He concluded that there was only one candidate -Mrs. Annabi, CIML Member for Tunisia - who is willing to act as Chairperson of the Council.

Mrs. Annabi gave a brief presentation of her recent activities and expressed her interest to be more actively involved in development matters.

The Development Council elected Mrs. Annabi as Chairperson for two years by unanimous open vote and Mr. Faber congratulated Mrs. Annabi and expressed his good wishes to her on behalf of the Council.

Mrs. Annabi thanked Delegates for their confidence in voting for her and briefly outlined her objectives in favor of developing countries, which in fact make up two-thirds of the total OIML membership.

It was decided to hold the next Development Council Meeting in conjunction with the 34th CIML Meeting in Tunisia, and the results of the Council Meeting were reported at the 33rd CIML Meeting.

Agenda – 33rd CIML Meeting

Opening addresses
Roll-call - Quorum
Approval of the Agenda

1 Approval of the minutes of the 32nd CIML Meeting

2 Member States and Corresponding Members
2.1 New Members - Expected accessions
2.2 Situation of certain Members
2.3 Proposals aimed at increasing the participation of Corresponding Members in certain OIML activities

3 Financial matters
3.1 Adoption of the Auditor's report for 1997
3.2 Examination of the financial situation for 1998
3.3 Examination of the budgets for 1999 and 2000

4 OIML Long-term Policy
4.1 General information concerning the international Seminar *The Role of Metrology in Economic and Social Development* (Braunschweig, June 1998) and its possible impact on the OIML Long-term Policy
4.2 The Birkeland Study

5 Developing Countries
5.1 Information on the outputs of the Braunschweig international Seminar and on the meeting of the OIML Development Council held on 28 October 1998
5.2 Examination of proposals from the Development Council

6 Liaisons with international and regional institutions
6.1 BIPM and ILAC
6.2 JCGM
6.3 WTO
6.4 Others

7 Activities linked with mutual recognition of test results, accreditation, etc.

8 Technical activities
8.1 Examination of the situation of certain TC's/SC's
8.2 Approval of International Recommendations
8.3 Availability of OIML Publications on paper, on electronic media and through Internet

9 OIML Certificate System
9.1 Information concerning the operation of the System
9.2 Development of the System
9.3 New Recommendations applicable within the System

10 Report on BIML activities

11 Other matters
11.1 CIML Vice-President
11.2 BIML Director
11.3 BIML Assistant Director
11.4 APLMF proposals to the CIML

12 Future meetings
12.1 34th CIML Meeting (1999)
12.2 35th CIML Meeting and Eleventh OIML Conference (2000)

13 Adoption of Decisions and Resolutions

Closure

CIML Seoul 33rd Meeting

33rd CIML Meeting

Wednesday 28 – Friday 30 October 1998

Seventy-one Delegates represented forty-three countries, including *Mr. Knut Birkeland* (CIML Immediate Past-President) and three members of BIML Staff.

The Meeting was officially opened by *Mr. Gerard Faber, CIML President*. A welcome speech was delivered by *Mr. Seung-Bae Lee (Director General of KNITQ)* and in opening the Meeting *Mr. Faber* gave a summary of the key events that have marked the Organization over the last year. The texts of both these speeches are reproduced in full on the following pages.

The roll-call established that the quorum had been attained and the Agenda was approved without comment, as were the Minutes of the 32nd CIML Meeting in Rio (Item 1).

Item 2.1 New Members – Expected accessions

Mr. Athané announced that the OIML was pleased to welcome South Africa as a new Member State (represented at the Meeting by *Mr. Brian Beard*), and that Croatia was envisaging becoming a full Member possibly in 1999.

Item 2.2 Situation of certain Members

Three Corresponding Members were, however, de-listed in 1998 for not having paid their subscriptions for some time, and three full Member States will be reminded to pay their overdue subscriptions by the end of 1998 to avoid possible sanctions.

Item 2.3 Participation of Corresponding Members

Delegates were favorable to the suggestion that Corresponding Members be given the opportunity to participate more actively in OIML work; the results of an inquiry carried out by the BIML in June 1998 were distributed, showing that a number of Corresponding Members would be interested in attending CIML Meetings and in participating in TC/SC activities. The BIML will decide whether the payment of a fee is appropriate for the latter, and in which circumstances, and will contact Corresponding Members again to pursue this project.

Item 3.1 1997 Auditor's report

The 1997 financial report distributed to CIML Members in April this year did not give rise to any comments and was therefore adopted; it will be submitted to the 11th Conference for sanction.

Item 3.2 1998 Financial situation

The financial situation for 1998 is good with an additional income due to the accession of South Africa.

Item 3.3 1999 Budget

Despite a degree of uncertainty as to the BIML's expenses for 1999 due mainly to staff changes, contributions should increase by less than the amount originally announced (and approved) at the Vancouver Conference, again due to the accession of South Africa; the average increase over the period 1996–1999 should be around 0.3 % p.a.; this increase is far below the average rate of inflation in Europe.

Delegates attending the 33rd CIML Meeting in Seoul

Opening speech by Mr. Seung-Bae Lee, Director General, KNITQ

President Faber, Delegates, Ladies and Gentlemen,

On behalf of the Korean National Institute of Technology and Quality, I am very pleased to host the 33rd Meeting of the International Committee of Legal Metrology in the Republic of Korea. And I would like to take this opportunity to extend my sincere appreciation to all the CIML Members for their decision three years ago to hold this meeting in Seoul.

I would also like to deliver my heartfelt thanks and greetings to all those delegates who have traveled so far to be with us in Seoul this week. Though Korea is currently experiencing an economic readjustment period, our country's economic development after the Korean War is regarded as being one of the fastest in the world. In this rapid industrialization process, the Korean economy needed the right legal metrology system which could accommodate the vast expansion of commercial transactions and the introduction of new measuring devices. By becoming a member of the OIML, Korea could learn from other countries' experiences in legal metrology, and could modernize its legal metrology system to support Korean people and industry.

Today, as the importance of international trade in the global economy attracts more attention than ever, one more role is now being added to the traditional missions of legal metrology, which is to promote global trade by eliminating unnecessary technical barriers to trade.

The OIML's International Recommendations have already provided us with essential tools to remove such TBT's by enabling us to harmonize OIML Members' standards and technical regulations in legal metrology areas. And I also believe the OIML Certificate System will form an essential infrastructure in the mutual recognition agreements in legal metrology products. In this respect, I am confident that the OIML has contributed – and will continue to contribute – to the global economy by providing necessary infrastructures such as standards, MRA's and training programs for developing economies.

As I have already mentioned, Korea's economic progress has owed much to the international community. Now, as an active player in the international trade system, Korea hopes to contribute more actively to international organizations. The decision to host the 33rd CIML Meeting, together with the 5th APLMF Meeting, came from our new commitment to global collaboration. I sincerely believe that this occasion will prove to be another cornerstone in our history in legal metrology.

Before closing, I personally hope that you will have time to look around Seoul and visit the historic palaces and museums where you can appreciate the traditional beauties of Korea.

I would like to thank you again for coming to Korea, and let me offer you my best wishes for a most successful and rewarding meeting.

Thank you.

Mr. Faber warmly thanked Mr. Seung-Bae Lee for his welcome speech and expressed CIML Members' gratitude for his invitiation to Seoul.

The BIML's objective, whilst confronted with an ever-increasing workload which may necessitate a staff increase in the not too distant future, is to keep contributions as low as possible.

Item 4.1 Braunschweig Seminar

Mr. Kochsiek then gave a detailed report on the possible impact of the Braunschweig International Seminar *The Role of Metrology in Economic and Social Development* (June 1998) on OIML Long-term Policy; in the name of all those who attended the Seminar, *Mr. Faber* especially thanked the PTB who had very successfully organized the event. The Seminar represents a milestone in our Organization's life and *Mr. Kochsiek's* report is outlined in the Development Council Meeting account; a detailed report was also published in the October 1998 OIML Bulletin, pages 48–60. This point was discussed again under Item 5.1.

Opening speech by Mr. Gerard J. Faber, CIML President

My dear Colleagues,

It is, as ever, a real pleasure for me to meet you again on the occasion of this, the 33rd meeting of our Committee.

On behalf of all of you I would like to reiterate our deep appreciation to the Director General of the Korean National Institute of Technology and Quality, Dr. Seung-Bae Lee for his kind invitation to meet in Seoul, and to express our sincere thanks to our Korean Colleague, Mr. Yoo-Jin Koh, and to all those who have participated in the preparation of this meeting. From what I have already seen, it is my conviction that this meeting has been very well prepared and that I will again have the pleasure of expressing my thanks on Friday when we close our discussions.

According to tradition, this opening address mainly aims at pointing out those items on the agenda for which the Presidential Council and myself have concentrated our efforts over the past twelve months, and for which I expect interesting and fruitful discussions. It also aims at summarizing the most significant events in the life of our Organization since our last meeting in Rio.

In this connection I would first of all like to mention the changes that have occurred in our Committee.

As you probably all know, sadly one of our Members passed away in June this year: Mr. Kakumba, our Colleague from Zambia. May I ask you to stand up to observe an instant of silence in his memory .... Thank you.

The other changes in the composition of our Committee are the following:

- for Austria, Mr. Leitner has replaced Mr. Galle,
- for Egypt, Mr. El-Naggar has replaced Mr. El-Sebai,
- for Ireland, Mr. Dempsey has replaced Mr. Murray,
- for Israel, Mr. Zarin has replaced Mr. Deitch,
- for Romania, Mr. Ocneanu has been replaced by Mr. Stoichitoiu, who was in fact CIML Member some years ago,
- for Sweden, Mr. Nyström has replaced Mrs. Ebbesson, and
- for Zambia, Mr. Sinyangwe has replaced Mr. Kakumba.

I am very pleased to welcome these new colleagues who are present today and I thank them in advance for their active participation in our meeting.

But these changes in the current composition of our Committee do not fully represent the changes that affect our Organization as a whole.

It is in fact my pleasure to inform you that the accession of the Republic of South Africa as an OIML Member State has been registered by the French Government, which is the trustee of the OIML Convention.

It was not possible for the South African Government to appoint a CIML Member in time for our 33rd meeting. However, I am sure that you will all agree to accept Mr. Beard's participation in our meeting with all the prerogatives of a full CIML Member. Welcome, Mr. Beard, to the international legal metrology community.

Other accessions are expected, as will be reported under item 2 of our agenda, but they do not affect our present meeting.

Let me now come to the main items on our agenda.

As you know, an important event has marked this year: the International Seminar which was held in Braunschweig, organized by the PTB with the participation of the BIPM, IMEKO and the OIML.

Many of you attended this Seminar, of which a report has been published in the October issue of the OIML Bulletin, pending the publication of the official proceedings.

We will have to come back to this event and look at its possible impact on our future activities.

In parallel the Birkeland report has progressed and a final version has been sent to you all a few weeks ago. Additional copies are available for those of you who have not received it.

It is my intent to devote all the time necessary to this report, but not to try to amend it - it is after all the Birkeland report, as drafted by Knut Birkeland, and I think that it should remain unchanged as such. What I suggest to you is to examine the conclusions and recommendations, and to discuss the best way to implement those which seem opportune to us.

We are living in a rapidly changing world. Many of the international and regional bodies with which we have contacts are themselves advancing in order to better fit in with the requirements of our society. The OIML should not lag behind; we too must advance and constantly adapt to the changing world, or else we will just disappear.

It is therefore my hope that, based on the output of the Braunschweig Seminar, on the Birkeland report and on our discussions this week, the BIML and the Presidential Council will be able to quickly develop concrete proposals for action, which will be approved by you not later than during our 34th meeting.

Let me now conclude this opening address with some remarks concerning the CIML Presidency and the BIML Director.

As some of you already know, I will retire from the Netherlands Meetinstituut as of 1st December this year after having served my organization more than forty years.

However, my Government is taking all necessary measures in order to allow me to continue to hold my international position according to the OIML Convention. I hope that, with your continuing support, I will be able to devote even more time to the OIML and contribute to its development.

Concerning our Vice-President Manfred Kochsiek, he was elected in 1991. I strongly believe that his participation in our work is essential. Therefore, under item 11.1 of the agenda, I will suggest that you reelect him for a new six-year term ending in 2003.

Finally, I would like to say a few words concerning the position of the BIML Director. Mr. Athané's current five-year contract will end on 31st December 2000. We are therefore confronted with the following problem: in the year 2000 both my own term as your President as well as Mr. Athané's contract will end. In view of the need for continuity, especially in this time of crucial changes in legal metrology, I will develop adequate proposals this week in close cooperation with the Presidential Council, to face the situation.

I will come back to this when we are at item 11.2 of the agenda. Of course, those of you who may wish to express their views concerning this matter may contact me personally before Friday.

My dear Colleagues,

These are the main items I would like to discuss with you during the next two and a half days. There are other equally important items on the agenda, for example those dealing with technical activities, certification, mutual recognition agreements, and developing countries. I am confident that with your active participation, all these topics will be the subject of discussions as a basis for our future activity.

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

Item 4.2 Birkeland Study

In-depth discussions ensued on the Birkeland Study. Introducing the subject, *Gerard Faber* emphasized that the OIML must be prepared to react to its changing external environment, taking into account three key issues:

- New areas where legal metrology is involved, notably in the environment and public health fields;
- Globalization of trade; and
- The growth of regional organizations – regional legal metrology bodies are bringing added benefits and the OIML should consider what it can best do as a worldwide inter-governmental organization to coordinate these activities.

The Birkeland Study is now finalized; it will be analyzed by the BIML and a key action strategy document drawn up during 1999 which will be integrated into the OIML Long-term Policy. *"What does the world expect of legal metrology and how can the OIML adapt to meet these needs"* is the key objective to be borne in mind. *Seton Bennett (UK)* reacted by advising that the first task should be to prioritize actions and identify the most important conclusions of the Study; all the recommendations cannot be implemented at the same time, so a choice must be made as to where to start.

Particular consideration was given to the Annexes to the Birkeland Study. These gave rise to detailed and interesting discussions; the key comments put forward are presented below.

a) The current lack of coherence in metrology legislation requiring perhaps a revision of OIML D 1

Mr. Magana (France) stated that the role of the State is changing and becoming more political; technical work is increasingly being delegated to private bodies. The CIML should address politicians to explain that interministerial coordination is essential; this point should be reflected in OIML D 1. Ministries would appear not to be too happy with this type of coordination.

Mr. Birch (Australia) said that the problem of legislation has also been highlighted in the Asia-Pacific area; legislation is the language of governments and should form the basis of legal metrology.

Mr. Vaucher (Switzerland) reported that Switzerland supports most of the conclusions of the Study, though has concerns about the cost, time necessary and also the feasibility of implementing all the recommendations.

Mr. Beard (South Africa) mentioned that South Africa has decided to harmonize regulations and would appreciate guidelines aimed at avoiding continual changes in legislation.

Mr. Klenovský (Czech Republic) suggested that the OIML might harmonize control of prepackages, and of software used for legal transactions.

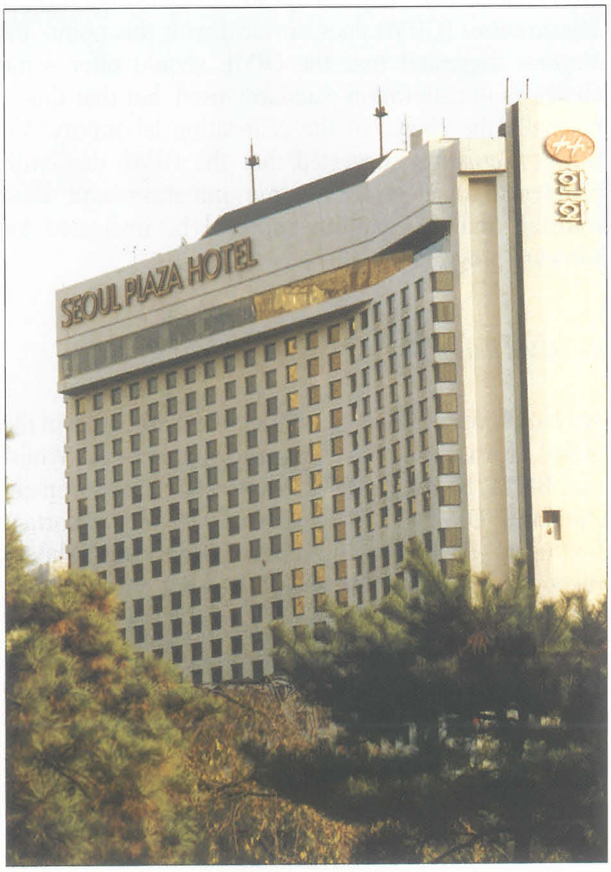
Mr. Magana supported *Mr. Klenovský's* idea since modern developments in software technology can lead to an increase in the risk of fraud; this is a growing problem which demands an urgent new approach. *Mr. Magana* suggested organizing a round table or a seminar on the subject of software in the near future, which he would organize with the BIML. This idea was received favorably by Delegates.

Mr. Magana agreed that the scope of legal metrology must be widened to accommodate modern advances in technology, and *Mr. Chappell (USA)* reiterated that the development of harmonized laws is very important; developed countries should help those in development. We must react to economic and social changes over time.

In summing up remarks to this first point, *Mr. Birkeland (CIML Immediate Past President and author of the Study)* stated that revising OIML D 1 was a high priority task; TC 3 should be charged with this.

Mr. Birkeland reminded Delegates that the OIML's purpose is to "serve the world"; modern legal metrology is a complex field which includes weights and measures, though by no means exclusively. He also repeated that initiatives have been put forward in his Study which may serve to improve the role of the Organization, though his intention was not to suggest ways of improving national metrology institutes; this was in reaction to a number of Delegates' descriptions of their own *national* difficulties, which is clearly out of the scope of the OIML.

He made a point of warning CIML Members not to be afraid of change, but rather to be scared of *not* changing – i.e. stagnating. All of his recommendations imply changes by means of which the OIML can better adapt to the outside changing world.



Mr. Kochsiek (Germany) expressed the concern firstly that in a united Europe, some legal metrology authorities (of which there may soon be around 20) may not wish – or be able – to take an active part in OIML technical activities; this would hinder the OIML's global European harmonization objectives. Secondly, Europe is moving more towards Directives (such as the MID *Measuring Instruments Directive*), the outcome of which may be that it is no longer necessary for manufacturers to ask for pattern approval as there may be other ways of obtaining approvals. Thirdly, manufacturers may go for the "one-stop shopping" concept of asking issuing authorities not only for pattern approval, but also (for example) for electromagnetic interference approval, the CE mark and so on, under Directives. Lastly, *Mr. Kochsiek* reiterated the need for inspection bodies to protect consumers against fraud and possible misinterpretation of certificates. These four points will have an influence on OIML work.

Mr. Pákay (Hungary) supported these comments; Hungary faces similar problems. To support legal metrology, the OIML should concentrate on interacting with regional organizations, whilst still remaining within the scope of legal metrology – i.e. with no loss of identity for the OIML.

Mr. Ramirez (Cuba) suggested that the problem was not so much revising the Law (D 1), but how to successfully implement it.

Mr. Nyström (Sweden) said that Sweden has recently tried to improve cooperation between the OIML and ISO/IEC standardizers; the latter were not even aware of OIML work! If there are already two major organizations who (in certain countries) are not working together, there may be others elsewhere. This situation is inefficient, and it would not be appropriate to have one set of voluntary standards and one set of legal metrology ones. In addition, industry has not been that involved in OIML work in Sweden. Should the OIML not rather concentrate on policy-making and leave standardization to the national authorities?

Mr. Birch affirmed that OIML policy should be readjusted to take into account the "ideal" model of legal metrology; the Birkeland Study is about modernization and harmonization of legal metrology and so *Mr. Birch* suggested holding a full-scale discussion on the European model.

Mr. Bennett supported *Mr. Birch's* views that the OIML cannot ignore what is happening in Europe; WELMEC may be able to provide useful information to the OIML in this respect. It is a pity the OIML could not have produced documents which could have formed the basis of European legislation; this proves the OIML's current inability to react quickly to changing circumstances, hence the importance of the Birkeland Study.

b) International uniformity and transparency in accreditation

Mr. Magana reported that work has begun on mutual recognition; this will be discussed in more detail under Item 7. Should we limit ourselves to ISO Guide 25 or also consider the implications of EN 45001, etc.? The role of accreditation is to create mutual confidence between accrediting bodies; will ILAC and other organizations be able to offer us this confidence? We must work with them to this end.

Mr. Birch continued this discussion point by explaining that ISO Guide 25 is appropriate for the accreditation of test laboratories for pattern approval testing; to what extent can it be extended to the "final measurement"? ISO claims it should provide confidence in all technical activities. Whilst instrument approval is important, if the OIML sets up a global system, we must certify final measurements with the appropriate confidence. Our current activities do not necessarily cover this, giving rise to a potential future work program.

Mr. Magnan (Canada) said that the Birkeland Study covers a wide range of issues, and will represent a challenge for the OIML and its Member States for years to come. There is no straightforward strategy and many areas will have to be addressed. Each of these would merit a whole day's discussions!

Mr. Faber reminded Delegates that the objective of the Birkeland Study is to highlight as many issues as possible, and allow CIML Members to voice their opinions in order to spark off ideas for concrete action.

Mr. Athané confirmed that all the discussions are being taped; it will be the BIML's responsibility to transcribe them and then bring valid proposals together into an action plan after possible modification. It may be necessary to establish a Study Working Group, but at any rate it is hoped that the action plan can be finalized in time for it to be approved at the 1999 Meeting after previously being submitted for the consideration of CIML Members in the Spring of 1999.

36 Delegates attended the technical visit to KRISS Laboratories

Mr. Gaba (Czech Republic) saw the Birkeland Study as a "mirror" in which the OIML is reflected; the report highlights areas to be developed with a sense of urgency, since OIML Recommendations and Documents do not always solve all the problems.

Mr. Kildal (Norway) said that it would be regrettable if the OIML changed its objective from front-end technical work to policy-making, as suggested earlier. Recommendations are useful, and the OIML technical committees stimulate discussion.

Mr. Beard felt that the OIML needs to set objectives for accreditation – we need to put guidelines together to be recognized by ILAC.

Mr. Birkeland commented that whilst the discussions were of great interest and each remark could lead to a number of others, it was important to focus attention on the *actual* discussion point in question, due to time constraints. Summing up discussions on this point, he affirmed that the OIML has an obligation to try to create global uniformity of accreditation.

c) Conformity assessment procedures – Compliance documentation – Mutual recognition agreements

There were a limited number of comments to these recommendations, and some confusion as to what was meant by an uncertainty of a maximum permissible error; the *Guide to the Expression of Uncertainty in Measurement* (GUM) does not deal with this point. *Mr. Magana* suggested that the OIML should offer some choice as to calibration standards used, but that this is normally the choice of the calibration laboratory. *Mr. Gögge (Germany)* suggested that the OIML deal with problems of electronic communication and data transfer, and that pattern approval be instigated for software programs.

d) OIML liaisons

Mr. Issaev made two points: firstly, the OIML's role in the global measurement system must be considered. Whilst the BIPM is responsible for primary measurement standards, OIML Recommendations are very important for users of measuring instruments. But who is responsible for the traceability from international measurement standards through to the manufacturer? The OIML could fill this gap.

Secondly, the OIML should take initiatives to coordinate the role of regional legal metrology bodies such as the APLMF, WELMEC, etc.

Mr. Magana felt that cooperation could be considered with ILAC, with the WTO and with regional development banks, including taking into account the way in which regional bodies will interact with the OIML; how can this best be harmonized? It is necessary to work together both at international and regional levels.

Mr. Klenovský suggested also involving consumers in liaison activities, who may be able to help in defining the real needs of legal metrology. *Mr. Nyström* supported *Mr. Klenovský's* idea, and suggested involving manufactures and industry as a whole as well as consumers.

Mr. Vaucher suggested also increasing liaisons with the World Health Organization, particularly important for matters of public health (which is an important area of legal metrology).

Mr. Bennett proposed that the OIML should take into account actions undertaken by the European Commission, which proposes metrological legislation; however the proposition to form a *Joint Committee of Regional Legal Metrology Bodies* should be postponed until further contacts have been made. It is first necessary to improve relations with regional organizations to avoid immediate substantial expenses being incurred – anyway, what benefits could be drawn from such a program?

e) Improving the role of the OIML

Mr. Bennett said that European countries are sometimes not free to enter into multi-lateral recognition agreements; in addition, these may not cover legal metrology issues so metrological regulations may be considered for inclusion in the future. However, these should be soundly based on technical regulations and compliance procedures which ensure consumer protection; the OIML must ensure that adequate ground work is done.

Mr. Kochsiek foresaw the problem that CIML Members may encounter difficulties in finding experts in certain fields; can experts in fields other than their own work for CIML Members? *Mr. Birch* agreed that the expanding scope of legal metrology must be integrated into OIML Long-term Policy, but is it appropriate for the OIML to draw up Recommendations on specific subjects (such as chemistry or health)? He felt that this is acceptable if the documents are written with a metrological slant since legal units of measurement, traceability and so on do apply to these fields; legal metrology serves to guarantee accuracy and protect against potential prosecution due to incorrect results. Legal units of measurement are therefore not just limited to "weights and measures" but apply to all measurements, though there must be an adequate legal metrology structure in place to cover this.

On the subject of coordination of activities with national government departments, *Mr. Chappell* remarked that in the USA, the Environmental Protection Agency (EPA) was initially reluctant to become involved with OIML projects, but has for some years become heavily involved in the compilation of Recommendations in areas such as measurement of pollutants by providing experts. CIML Members should therefore be encouraged to contact their national agencies concerned, with a view to obtaining similar positive collaboration.

In concluding discussions under "The Birkeland Study" *Mr. Faber* thanked Delegates for their very active participation, and especially thanked *Mr. Birkeland* for his very complete work which, he affirmed, would shape the future for the OIML and which he described as *"a masterpiece of thinking about legal metrology"*. This initial stage of research work is now finished – the next step is for the BIML to compile the document into a concrete action plan; no such document existed up to now and the onus is at present on the Organization to use it as a constructive tool.

Item 5 Developing Countries

Mr. Kochsiek gave a comprehensive account of the proceedings and outcomes of the Seminar held in Braunschweig last June (for the benefit of those Delegates who had not attended the Development Council Meeting); this report is mentioned in the Development Council Meeting account earlier in this section, and is also outlined in Item 4.1 above. A document produced by the BIML was distributed, covering proposals for the Development Council work program; the final version of this paper will be communicated to Members in about two months after editing.

Item 6.1 Liaisons with BIPM and ILAC

Mr. Faber gave information that relations with the BIPM were good; cooperation will be continued wherever

possible and a good example of this was the Braunschweig Seminar. The BIPM-OIML-ILAC Group has decided to meet once a year to develop cooperation and other appropriate matters; the next meeting is scheduled for February 1999. *Mr. Chappell* identified two key areas of CIML/CIPM cooperation: acoustics (TC 13) for which the CIPM may set up a working group, and hardness (TC 10) for which an ad hoc group has already been established by the CIPM in collaboration with OIML TC 10.

Mr. Chappell and *Mr. Athané* had attended an ILAC meeting in Sydney in the week prior to the CIML Meeting, during which ILAC was informed of developments in OIML work on accreditation. ILAC is currently involved in a number of interesting projects for which cooperation will continue. *Mr. Kildal* informed Delegates that ILAC had been offered the possibility of holding its permanent secretariat at the BIPM, and *Mr. Athané* reported that it had been announced during the ILAC General Assembly that Mr. Van de Leemput was willing to start a review of OIML D 10 on *Recalibration intervals* with the OIML.

After the 1997 Rio Meeting, *Mr. Athané* had contacted the IAF President and secretariat with a view to obtaining information on their activities and to ascertain whether it would be worthwhile setting up cooperation arrangements; *Mr. Athané* is considering this proposal. He also commented that matters might be simplified if ILAC and IAF were to merge some time in the future.

Item 6.2 JCGM

It was reported that the last meeting of the Joint Committee (of which the secretariat is held jointly by the BIPM and the BIML) was held at the BIML in November 1997. There is presently no need to revise the GUM (WG 1), but the activities of other organizations concerned with matters of uncertainty should be monitored.

WG 2 *(Revision of the VIM)* will hold its next meeting in November 1998. No JCGM Committee meeting is planned before 1999.

Item 6.3 WTO

Mr. Athané reported that the OIML had been granted Observer Status of the WTO TBT Committee, and BIML representatives have attended two meetings in Geneva during 1998. *Mr. Szilvássy* pointed out that Annex I of the Birkeland Study well describes the Agreement and *Mr. Athané* suggested that Members might wish to contact their national WTO Agencies with a view to establishing cooperation at national level.

Item 6.4 Others

Mr. Imai (Japan) reported that the 15th IMEKO World Congress will be held from June 13–18 1999 in Osaka, as announced in the July 1998 OIML Bulletin (page 66); some 450 technical papers have already been received and CIML Members are welcome to participate.

Mr. Athané mentioned that the BIML has participated in some 3–4 European Commission meetings on the Measuring Instruments Directive; the issue of whether an instrument that conforms to an OIML Recommendation would automatically conform to the MID needs clarification, if indeed this clause is still present in the MID.

Item 7 Activities linked with mutual recognition of test results, accreditation, etc.

Mr. Chappell gave a transparency presentation, a copy of which was distributed to Delegates. The presentation was a development of the one given during the 1997 Rio Workshop *Metrology Development in the World* on *Accreditation in Legal Metrology*. The scope of voluntary OIML mutual recognition is acceptance of OIML certificates and use of pattern evaluation test reports. Mutual confidence is established by the accreditation of evaluation laboratories, peer reviews, exchange of information regarding national capability for testing, training of testing laboratory personnel, exchange of test data and intercomparisons.

Documents considered are the OIML Certificate System for Measuring Instruments, the US-Canada MRA on Type Evaluation and the WELMEC Type Approval Agreement.

Five meetings have been held since February 1997, including a mutual agreements meeting held at NIST in April 1998 involving 11 participants. Further documents will be distributed by December 1998 and these activities will be reported to the CIML again at its 34th Meeting in 1999.

A number of Delegates commented on the accreditation situation: are documents on MRA's developed by other groups being considered; what about third party testing and software control, etc. *Mr. Bennett* reminded participants that we still do not have a final document, some two years after the Vancouver Round Table on Accreditation. An ad hoc (i.e. temporary) working group was set up at that time, which should be reformed as a new TC or TAG so that this item remains topical. He also suggested that the BIML should set up a register of accredited laboratories for legal metrology; this might be made available on Internet.

Item 8.1 Situation of certain TC's/SC's (technical activities)

A report was given by *Mr. Chappell* and a document produced by the BIML was distributed. Detailed information on OIML technical activities will be published in the April 1999 of the OIML Bulletin. However, it may be noted that two subcommittees with important ongoing projects were still waiting for a country to volunteer to be the Secretariat: TC 3/SC 4 *Application of statistical methods* for which Germany has volunteered and TC 7/SC 3 *Measurement of areas* for which the UK and Australia have also volunteered.*

Mr. Szilvássy remarked that the BIML has this year received 9 new projects plus 6 new Draft Recommendations; some 13 new CD's are expected by the end of 1998. At the 1999 CIML Meeting, Members could therefore expect to vote on some 10 new Recommendations.

Item 8.2 Approval of International Recommendations

Five out of the six Draft Recommendations were approved by the CIML:

PR 1 Test procedures and test report format for indicating and recording pressure gauges, vacuum gauges and pressure-vacuum gauges with elastic sensing elements (Ordinary instruments) – Addendum to R 101;

PR 2 Test procedures and test report format for pressure gauges and vacuum gauges with elastic sensing elements (Standard instruments) – Addendum to R 109;

PR 3 Radiochromic film dosimetry system for ionizing radiation processing of materials and products – New Recommendation: R 127;

PR 5 Focimeters – Revision of R 93;

PR 6 Ergometers for foot crank work – New Recommendation: R 128.

Approval of **PR 4** Force measuring system of uniaxial material testing machines – Revision of R 65 – was postponed pending clarification with ISO TC 164.

Item 8.3 Availability of OIML Recommendations

Mr. Athané explained that OIML Publications are currently being printed at a financial loss; the medium-term objective would be to make Publications available only on disk or on Internet to avoid the expense of paper printing; a survey will be carried out by the BIML to ascertain whether this is feasible. There is also the question of payment – if Publications are available on the Internet, a payment/password system will have to be instigated to safeguard against unauthorized access.

He further remarked that despite the ever-increasing workload of BIML technical staff, all the Recommendations approved in 1997 have now been edited, printed and distributed on schedule. The BIML had also received a number of encouraging remarks from Members as to the improved layout of Recommendations and the attractive changing style of the Bulletin.

Item 9 OIML Certificate System

The BIML produced a detailed report which was distributed. Since 1995 the number of Recommendations applicable within the System has been increased to 26. The evolution of the System was discussed at the Presidential Council (Paris, February 1998); certification activities of TC's/SC's, accreditation of laboratories, mutual acceptation of test results and other items were also considered.

This year the BIML carried out a second inquiry concerning the implementation and promotion of OIML certification and application of the System. The results of the responses received from 67 countries (from about 2/3 of the Member States and 2/3 of the Corresponding Members) to the two inquiries (1997, 1998) were summarized.

Four new categories of instruments are covered by the System with the publication in 1998 of OIML Recommendations R 58, R 85, R 88 and R 126, and the number of OIML certificates issued as at 20 October 1998 is 401.

The Bureau continued collecting and distributing information about the System. OIML certificates are sent to all Members, systematically registered, put on the OIML web site and classified by various features: category of instrument, issuing authority, member country, applicant, manufacturer, year of issue, etc. Information on the System is also published in the OIML Bulletin.

The developments in conformity assessment, certification, accreditation activities of international and regional bodies (ISO/IEC, ILAC, EAL, WELMEC, APLMF, UN/ECE and recently the WTO TBT Committee) were followed up and studied by the Bureau with a view to applying them within the System.

Based on the guidelines formulated by the 10th Conference, discussions held during (and decisions made at) CIML and Presidential Council meetings and inputs from other organizations, etc. a series of actions is to be jointly undertaken by OIML technical bodies, CIML Members and the BIML with the objective of further developing the System. These actions are summarized below:

* The Secretariat for OIML TC 3/SC 4 has since been allocated to Germany.
The Secretariat for OIML TC 7/SC 3 has yet to be decided between the UK and Australia.

- Revision of the basic documents P 1 (BIML + TC 3) and D 13 (TC 3/SC 1) with the inclusion of references to the OIML Mutual Agreement and WTO TBT Agreement;
- Revitalization of TAG_{cert} with special regard to related activities of TC 3, TC 4 and the WG on accreditation in legal metrology;
- Drafting of a policy paper on the legal status of the System, establishing links between OIML certificates and national systems;
- Raising confidence of issuing authorities and others (Mutual agreement on OIML pattern evaluation, organization of peer reviews and OIML comparisons);
- Application of accreditation procedures to OIML certification;
- To widen the base of Recommendations applicable within the System;
- To advance ongoing revisions and development of Annexes;
- Development of projects to be started (e.g. TC 8 questionnaire on 7 Recommendations);
- To be addressed: several issues (e.g. questions relative to the Revision of R 111 (certificate for sets of weights, each piece of weights, etc.), countries with more than one issuing authority, possibility of Corresponding Members having an issuing authority, etc.);
- To give priority to the revision of Recommendations and development of a test report format for utility meters;
- To keep other international and regional organizations in liaison with OIML informed about the advantages and further development of the System (mutual agreement, peer-evaluation of issuing authority, etc.);
- OIML Certificate System and the WTO TBT Committee: the OIML may take advantage of its status of Observer within the Committee to promote its certification activities;
- Distribution of a new information brochure (BIML) for information of interested parties (CIML Members, Corresponding Members, manufacturers and users) for promotional purposes and to encourage acceptance of certificates;
- Inquiry among manufacturers of measuring instruments with a potential interest in the System with a view to better understanding their demands and hence encouraging them to better utilize it;
- To draft information and seminar material for Developing Countries to help them to implement the System and to accept OIML certificates.

The results of the BIML inquiry are summarized below:

- 25 (19 last year) countries received requests from manufacturers of other countries for the recognition of OIML certificates and/or test results;
- 22 (16) countries replied that certificates were taken into consideration and in 7 (5) countries certificates were accepted to replace national type evaluation or approval;
- In general, more than 200 (120) certificates were either accepted or taken into consideration to facilitate the process of national type approval for categories of instruments covered by OIML Recommendations R 51, R 60, R 61, R 76, R 117/118 and R 107 in 1998. The largest number of certificates (more than 80 %) referred to R 76 *Nonautomatic weighing instruments* and R 60 *Load cells*;
- Some EU countries indicated their acceptance of OIML certificates within the framework of the WELMEC Type Approval Agreement;
- In 39 (30) countries, manufacturers and users were informed about the System and its possible advantages and in 18 (13) countries mainly positive reactions have been received from manufacturers;
- Manufacturers in 16 (13) countries have applied to their national services for an OIML certificate;
- 18 + 1 Member States have established their own issuing authorities and 20 (16) Member States (and 9 Corresponding Members) indicated their intention to establish authorities in the near future;
- Promotion of the System was achieved by publications in national press in 22 (18) countries, dissemination of BIML documents in 32 (23) countries, conducting seminars and training including the subject of the System in 18 (11) countries;
- 15 (11) countries indicated that specific actions had already been taken to promote the System;

- 13 Member States and 1 Corresponding Member out of 26 countries that replied to both inquiries clearly indicated positive changes during the period between the inquiries in the promotion of the System and/or in recognition of certain certificates and in acceptance of test results.

Developing countries require:

- More detailed and regular information on the System;
- Training/seminars on the functioning and implementation of the System;
- Technical assistance and financial support to purchase testing equipment, to establish testing laboratory and to train staff.

Item 10 BIML Activities

Mr. Athané distributed a detailed account of BIML activities since the last CIML Meeting, and again stressed the BIML's increasing workload. This report is published later in this Bulletin.

Item 11.1 Election of CIML Vice-President

Manfred Kochsiek was re-elected unanimously until 2003. The CIML expressed its thanks to *Mr. Kochsiek* for his hard work and dedication.

Item 11.2 BIML Director

Mr. Faber informed the Committee that the succession of Mr. Athané (whose contract ends in the year 2000) will be considered by the Presidential Council.

Item 11.3 BIML Assistant Director

Mr. Ian Dunmill, currently at the NWML (UK), was elected BIML Assistant Director to replace *Miss Nathalie Dupuis-Désormeaux*, who resigned from her position in October this year.

Item 11.4 APLMF proposals to the CIML

Mr. Birch transmitted proposals from the APLMF that the OIML should work on the development of an international system of marking of prepacked goods, the rapid revision of Recommendations on utility meters and their inclusion in the OIML Certificate System.

Item 12 Future meetings

Mrs. Annabi (Tunisia), who had invited the CIML to hold its 34th Meeting in 1999 in Tunisia, gave a presentation

Mrs. Ghaïet El-Mouna Annabi
was elected Chairperson of the Development Council and will host the 1999 CIML Meeting in Tunisia

on her country, which led to CIML Members unanimously accepting her invitation – the date will be fixed shortly to fit in with other meetings next September/ October.

Pending imminent confirmation, *Mr. Bennett* invited the CIML to the UK in the year 2000 for the 35th Meeting and Eleventh Conference, and *Mr. Issaev* expressed the wish to hold the 2001 Meeting in Russia.

Item 13 Decisions and Resolutions

The Decisions and Resolutions of the 33rd CIML Meeting were distributed and commented by *Mr. Athané* and the meeting was officially closed by President *Faber* who, on behalf of Delegates, expressed his sincere thanks to the KNITQ and to all the organizing personnel for their perfect organization of the event.

Some Delegates enjoyed a technical visit to the Korean national metrology laboratory (KRISS) on Tuesday 27 October and were free to discover the wonderful sights of the city of Seoul on Friday afternoon. ■

The Asia-Pacific Legal Metrology Forum held its Fifth Meeting prior to the OIML Meetings - Delegates are pictured above

OIML Liaison Activities

ISO Committee on Developing Country Matters (DEVCO)

32nd meeting

Geneva, Switzerland

14–15 September 1998

Participation

More than 100 participants from 57 Member Countries and from three international organizations:

- UNCTAD/WTO/International Trade Center (ITC);
- UNIDO;
- OIML.

Main Points

Opening address

Mr. Liew Mun Leong, ISO President stated that he encourages Members to donate part or all of their savings from next year's reduced fees to the Funds in Trust to help DEVCO. In addition, Mr. Liew Mun Leong mentioned that communication between ISO and governments will take place to explain the role that the National Standards Bodies can play. To increase participation by developing countries, Mr. Liew Mun Leong suggested that Secretariats of TC's and SC's could be shared.

New Publications

- ISO/DEVCO has now published the second edition of *Development Manual 2: Conformity Assessment.*
- The document *Development Manual 10: Environmental Management* is soon to be printed by ISO/DEVCO.
- ISO/INFCO has developed a promotional package for use by Members when promoting the importance of standardization within their country. ISO/INFCO is responsible for marketing aspects of ISO; this includes communications, sales and promotion activities.

Training

- A large number of training seminars were held during 1998 and more are planned for 1999, mostly regarding ISO 9000 and ISO 14000. Some of the past seminars were sponsored by AENOR (Spain), AFNOR (France), DIN (Germany), IMQ (Italy), PSB (Singapore), SAA (Australia) and the Swiss Government.

International Standards needed by Developing Countries

- ISO/DEVCO Members are developing requirements for *Manually operated hand pumps*.

Documentation and information systems and application of information technology (IT) and telecommunications in standardization

- Recognizing IT and telecommunications as an important tool for standardization in the 21st century, ISO created ITSIG.
- ISO/DEVCO performed a survey to evaluate the needs of DEVPRO beneficiaries in the area of information technology and noted difficulties experienced by many developing countries in keeping up with information technology.
- ISO/DEVCO has ongoing negotiations with UNCTAD to assist ISO Members from developing countries in this field with possible financing from the Government of Italy in particular from Mediterranean countries and from the Horn of Africa.
- ISO/DEVCO has been requested to seek support from donors to extend the implementation of this project in other regions as well.

ISO/CASCO

- A list of CASCO's active working groups and Work Program were provided, where:

  WG5 Definitions

  Task: Development of the conformity assessment part of the current ISO/IEC Guide 2: 1996 as an International Standard;

  WG10 Revision of ISO/IEC Guide 25: 1990

  Task: Revision of ISO/IEC Guide 25 such that it may be adopted as an International Standard. Clauses are being re-written so that it is clear when they are requirements and when they are provided for guidance. When adopted by a laboratory, the revised document will allow demonstration of technical competence within a stated scope and compliance with ISO 9001 or ISO 9002.

  WG11 Mutual Recognition Agreements

  Task: Elaboration of guidelines for the development and maintenance of mutual recognition agreements.

  WG12 Use of marks of conformity assessment

  Task: Preparation of a report describing the current uses of conformity assessment marks and simplified concepts for their application.

  WG13 Environmental Management Systems (EMS)

  Task: Revision of the environmental management system and auditing standards from the perspective of conformity assessment, in particular third-party certification/registration.

  WG14 Fundamentals of product certification

  Task: Development of a document to provide information and criteria regarding implementation and operation of product certification programs. The document will provide identification of elements of product certification as reflected in ISO/IEC Guide 65. This document will provide examples of needs presently fulfilled by product certification programs and actual activities undertaken to meet those needs.

  WG15 ISO/IEC Guide 39

  Task: Revision of ISO/IEC Guide 39 using EN45004 as a basis.

  WG16 Accreditation of inspection bodies

  Task: Development of general requirements for bodies providing accreditation of inspection bodies.

- ISO/DEVCO has undertaken to provide CASCO with suggestions regarding topics of interest for Workshops to be held in the year 2000.
- A report was given on the Program Cooperation between ISO, UNIDO and IAF. This Cooperation intends to provide a pre-audit service for developing country accreditation bodies as a preparation for their formal application to join the IAF multilateral agreement (MLA).
- Pre-Peer Evaluation (PPE) of Accreditation Bodies: "The objective of the PPE is to establish international confidence in the ability of an accreditation body from a developing country to assess the performance of certification bodies. (...) Accreditation bodies in developing countries have a clear understanding of where they stand in their preparation for approval by the IAF Peer Evaluation and hence acceptance to sign the Multilateral Agreement." In January 1998, draft procedures were developed for Pre-Peer Evaluation of Accreditation Bodies; in July 1998, a joint workshop was hosted in Vienna by UNIDO; in September, the first team of assessors visited the Philippines; and in November, a PPE will take place in Colombia.

ISO/COPOLCO

- COPOLCO activities were discussed and the importance of COPOLCO in ensuring a better protection of consumers around the world regardless of economic development of the countries was emphasized.
- ISO Members were highly encouraged to contribute more actively in the work of COPOLCO even if only by correspondence.

ISO/REMCO

- The REMCO Project for Upgrading Analytical Laboratories in three Caribbean countries and extension of this project to four countries in South and Central America was discussed.
- ISO Members were encouraged to further their contributions to the above REMCO project.

Environmental Management

- It was agreed that DEVCO should intensify efforts to assist developing countries through re-enforcing cooperation with industrialized countries, investigating alternate methods of support from multilateral institutions and investigating ways of re-enforcing local means to sponsor participation of Members to ISO/TC207.

Other Matters

- DEVCO has approved the creation of a "virtual" advisory group to further explore ways of increasing participation of developing countries in ISO work.
- ISO/IEC Guide 56 will be withdrawn.
- A proposal for telephone and video conferencing was made to increase participation within working groups. It was suggested that this method was best suited for cases when members know each other.
- In a recent ISO survey, it was noted that approximately 40 of the 99 ISO Members did not have access to e-mail or Internet, and that there are many problems regarding access to computers and insufficient or inadequate telephone lines.

ISO DEVCO Developing Countries' Participation in ISO

Presentation by Mr. F. Tobón Londoño (ICONTEC, Columbia)

ISO Membership: "According to figures from ISO, the organization has 94 National Standards Bodies (NSB) from developing countries (Members, Correspondents and Subscriber members), out of a total of 128 members. The developing countries account for 73 % of the membership of the organization."

ISO/DEVCO Membership: "DEVCO has some 99 member countries, both as P and O members. Out of those 99 countries, there are 74 from developing countries or 75 % of the membership."

Mr. Tobón Londoño provided Table 1 below which shows the participation of industrialized and developing countries in ISO standardization work.

Further, Mr. Tobón Londoño mentioned that there is presently no ISO Vice-President from a developing country other than for ISO/DEVCO.

The ISO Council and the Central Secretariat have been sharing some services with IEC in an effort to reduce costs. Mr. Tobón Londoño suggests that while keeping the ISO fees as they are, the savings from cost-sharing could be re-directed to ISO/DEVCO.

Mr. Tobón Londoño recommends that DEVCO participate directly with the National Standards Bodies in discussions with their governments to help promote ISO's programs and to explain the necessity for standardization activities. Such a promotion campaign could be implemented through Regional Standards Organization, e.g., PASC, COPANT, ARSO.

The concept of shared responsibility was suggested, where a developing and an industrialized country could jointly hold the Secretariat for a given TC or SC. This would continue for a fixed period of time (e.g. two years) until the developed country is ready to take over the entire responsibility for the TC/SC.

Further, "Twinning" was proposed by Mr. Tobón Londoño as a mechanism to share expertise and resources. This suggests that a developing and an industrialized country could join forces with the aim to achieve specific objectives and goals. It was suggested that such a mechanism could be organized through Regional Standards Organizations.

A last suggestion for increased participation by developing countries in ISO work was the possibility of cost-sharing between certain developing countries and alternating their participation.

Mr. Tobón Londoño suggested that a "virtual" advisory group be created, composed of a maximum of seven members from different geographic regions, to further explore ways of increasing participation of developing countries in ISO work. This advisory group will have to provide an annual report at DEVCO's plenary session. ***This suggestion was endorsed by ISO/DEVCO.***

Table 1 participation of industrialized and developing countries in ISO standardization work

Participation	TC	SC	WG	TOTAL
Industrialized countries	173	551	1 921	2 645
Developing countries	10	19	29	58
Total	**183**	**570**	**1 950**	**2 703**
Percentage (%) of participation by developing countries	5.5 %	3.3 %	1.5 %	2.1 %

Symposium on Measurements and Measuring Equipment

Belgrade, Yugoslavia 6–8 October 1998

Z.M. Marković, Deputy Director, Federal Bureau of Measures and Precious Metals, Belgrade, Yugoslavia and CIML Member for Yugoslavia

Introduction

This year the Federal Bureau of Measures and Precious Metals commemorates its 125th anniversary, and hence 125 years of legal metrology in Yugoslavia.

On this occasion and in cooperation with the Serbian Academy of Science and Arts, the Montenegrin Academy of Science and Arts and the Society of Metrologists of Yugoslavia, the Bureau held the *Congress of Metrologists of Yugoslavia* in Belgrade from 20–21 May 1998 and the *Symposium on Measurements and Measuring Equipment* from 6–8 October. The motto of the jubilee year is

Accurate measurements for the 21st century.

Scope

The Symposium covered a wide range of metrology-related fields, and delegates attended from all over the Federal Republic of Yugoslavia. Authors presented some 110 papers in two plenary sessions and in sessions on the topics listed below; all the papers given have been published in two Symposium Proceedings volumes.

- Themes of general importance;
- Measurement applications;
- Measurement of mechanical quantities;
- Measurement of electrical quantities;
- Measurement of length;
- Measurement of volume;
- Measurement of temperature;
- Measurement of time and frequency;
- Measurement of ionizing radiation;
- Physical-chemical measurements;
- Photometry;
- Reference materials.

Proceedings of the Symposium

The Symposium was officially opened on Tuesday, October 6 by Prof. Dr. Jagoš Zelenović, Federal Minister for Development, Science and the Environment. He expressed his satisfaction at being able to welcome so many metrologists and wished the Symposium every success.

In his opening address, Prof. Dr. Mile Pešaljević, Director of the Federal Bureau of Measures and Precious Metals, welcomed the participants and gave brief information on the FBMPM.

In the Plenary Session on Thursday October 8, Mr. Bernard Athané, Director of the *Bureau International de Métrologie Légale*, presented a lecture entitled *"Trends in Legal Metrology and Relevant Activities of the International Organization of Legal Metrology (OIML)"*. He briefly presented the OIML, then explained the importance of legal metrology in today's society, OIML strategy, and gave some views concerning the possible future trends of legal metrology at national, regional and international levels.

Mr. Athané said that a decisive trend for the next ten years will be the development of regional cooperation in legal metrology; the OIML would have to ensure the necessary coordination between the various regions. Other equally important challenges will be deregulation, allocation of testing and verification of measuring instruments to non-public bodies, and the establishment of a real climate of confidence between countries concerning measurement results.

During the Symposium, an *"Exhibition of measuring instruments and equipment"* involving both domestic and foreign manufacturers took place at the Symposium venue; many participants also attended a technical visit to the FBMPM laboratories on Thursday October 8.

An Exhibition on *"125 Years of Legal Metrology in Yugoslavia"* was organized by the Museum of Science and Technology and the FBMPM from 5–30 October 1998 in the Gallery of Science and Technology at the Serbian Academy of Science and Arts.

Metrology is being given a high priority by governmental bodies; this was reinforced by Mr. Athané, who met at a reception with both Prof. Dr. Jagoš Zelenović and with Prime Minister Momir Bulatović. ■

Delegates attending the Symposium

2nd European Conference on Weigh-in-Motion

Lisbon, September 1998 (organized by the COST 323 Management Committee)

The second European conference on Weigh-in-Motion (WIM) was recently held in Lisbon, Portugal. While the organization and financial support for the conference was substantially European, there was a truly international flavor in both the speakers and the delegates, with 165 delegates from 30 countries attending. Apart from Europe, there were representatives from Asia, Australia, Africa and from North, Central and South America.

Weighing road vehicles in motion (WIM) consists of measuring wheel or axle effects in sensors usually mounted on or in the road pavement, and estimating the corresponding static loads or masses with appropriate algorithms. There are two main approaches, low-speed WIM and high-speed WIM. With low-speed WIM, the vehicles are diverted from the traffic flow to a specific weighing area where they are weighed at low speed (e.g. 5 km/h to 15 km/h) under the control of police personnel (see Fig. 1). With high-speed WIM, the sensors are placed in the traffic lanes and all the vehicles are automatically recorded as they pass at normal speeds (see Fig. 2). The first approach is mainly used for legal purposes (enforcement and trade) while the second one meets the other needs: traffic statistics, traffic and road monitoring, and road infrastructure design and assessment. For these latter applications, accuracy in the range of 10 % to 25 % with respect to the static weights is fully accepted.

It was clear that WIM had advanced considerably in many ways since the 1st Conference of the series, held in Zürich in 1995. There had, in the past, been some imprecision and inconsistency with the classification of the accuracy of WIM systems. In the Lisbon conference, all papers in which accuracy tests were reported, referred to the draft COST 323 WIM specification. This specification was developed by the COST 323 Management Committee in 1996–1997, and is now widely accepted by both manufacturers and users. It was recently submitted to the CEN, as a basis for a future European standard. A final version is expected to be published in 1999. There was an extensive discussion on specification and standardization of WIM with presentations on the ASTM standard, the COST 323 specification and the OIML draft Recommendation. The scope of this Recommendation is rather different from that of the two other documents. OIML only deals with legal applications; thus a metrological definition of the accuracy is used, with maximum permissible errors (mpe), while the two other documents mainly exclude trade applications and apply a statistical definition of accuracy using confidence intervals. At the conference, common rules were applied to all WIM system tests, in terms of the range of pre-weighed trucks used and the statistical basis for the classification.

A significant quantity of research was reported at the 2nd WIM conference on new and improved WIM technologies. The development of a fiber optic WIM system was reported. A number of research projects in bridge WIM were presented (bridge WIM uses instrumented bridges to weigh vehicles in motion). However, it was evident that the emphasis had moved from finding accurate and robust sensors towards the applications for which WIM data can be used. There were sessions on the application of WIM to pavements, enforcement, bridges and traffic management. Some of these applications such as bridge loading are reaching a level of maturity with established procedures being improved or extended. Other applications such as traffic management or pre-selection and enforcement of overloaded vehicles appear to still be at early stages of development with huge scope for further development in the future. ■

Fig. 1 Low speed WIM

Fig. 2 High speed WIM

Bernard Jacob

Chairman, COST 323 Management Committee
Laboratoire Central des Ponts et Chaussées
58 bd Lefèbvre, 75015 Paris, France

Eugene J. O'Brien

Vice-chair, COST 323 Management Committee
University College Dublin
Earlsfort Terrace, Dublin 2, Ireland

In this Bulletin: OIML certificates registered

Dans ce Bulletin: certificats OIML enregistrés

1998.08 – 1998.10

OIML Certificate System

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

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

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

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

Système de Certificats OIML

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

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

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

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

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

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

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

Physikalisch-Technische Bundesanstalt (PTB), Germany

R51/1996 - DE - 98.03

Type GS ... (Classes X(1) and Y(a))

Bizerba GmbH & Co. KG, Wilhelm-Kraut-Straße 65, D-72336 Balingen, Germany

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

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

OIML Recommendation applicable within the System / Year of publication

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

Year of issue

Année de délivrance

The code (ISO) of the Member State in which the certificate was issued.

Le code (ISO) indicatif de l'État Membre ayant délivré le certificat.

Certified pattern(s)

Modèle(s) certifié(s)

Applicant

Demandeur

For up to date information on OIML certificates:

Pour des informations à jour sur les certificats OIML:

http://www.oiml.org

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

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

R 51 (1996)

▶ Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R51/1996-DE-98.03
Type GS ... (Classes X(1) and Y(a))
Bizerba GmbH & Co. KG, Wilhelm-Kraut-Straße 65, D-72336 Balingen, Germany

R51/1996-DE-98.04
Type GV ... (Classes X(1) and Y(a))
Bizerba GmbH & Co. KG, Wilhelm-Kraut-Straße 65, D-72336 Balingen, Germany

R51/1996-DE-98.06
Types EC... (Class X(1))
Wipotec, Wägetechnik und Positioniersysteme GmbH, Adam-Hoffmann-Straße 26, 67657 Kaiserslautern, Germany

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Load cells
Cellules de pesée

R 60 (1991), Annex A (1993)

▶ Issuing Authority / *Autorité de délivrance*

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

R60/1991-NL-98.15
Type CB004-xxx-NS (Class C)
Minebea Co. Ltd., Measuring components div., Kuruizawa Factory Miyota-Machi, Kitasakugun Nagano-Ken, Japan

R60/1991-NL-98.16
Type MT1041-.... (Class C)
Mettler-Toledo Changzhou Scale Ltd., 111 Changxi Road, Changzhou, Jiangsu 213001, P.R. China

R60/1991-NL-98.17
MT1260 (Class C)
Mettler-Toledo Changzhou Scale Ltd., 111 Changxi Road, Changzhou, Jiangsu 213001, P.R. China

R60/1991-NL-98.18
MT12416-.... (Class C)
Mettler-Toledo Changzhou Scale Ltd., 111 Changxi Road, Changzhou, Jiangsu 213001, P.R. China

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic gravimentric filling instruments
Doseuses pondérales à fonctionnement automatique

R 61 (1996)

▶ Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R61/1996-DE-98.01
Dialog 165 accuracy class Ref (0.2)
Weber-Waagenbau u. Wägeelektronik GmbH, Boschstraße 7, 68753 Waghäusel 1, Germany

R61/1996-DE-98.02
ROTRONIC HS II accuracy class Ref (0.2)
Möllers GmbH u. Co, Sudhoferweg 93, 59269 Beckum, Germany

▶ Issuing Authority / *Autorité de délivrance*

National Weights and Measures Laboratory (NWML), United Kingdom

R61/1996-GB-98.01
Weighmaster S Series (Class X(2.0))
G. Webb Automation Ltd., Link Industrial Estate, Howsell Road, Malvern Link, Worcestershire WR14 1TF, United Kingdom

▶ Issuing Authority / *Autorité de délivrance*

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

R61/1996-NL-98.05
*Type CCW-DZ-****-*/**-** (Ref, Class X(1))*
Ishida Co., Ltd., 44, Sanno-cho, Shogoin, Sakayo-ku, Kyoto, 606, Japan

R61/1996-NL-98.06
*Type CCW-Z/EZ/RZ-****-*/**-** (Ref, Class X(1))*
Ishida Co., Ltd., 44, Sanno-cho, Shogoin, Sakayo-ku, Kyoto, 606, 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*

Sous-direction de la Métrologie, France

R76/1992-FR-97.02 Rev. 1
Balance électronique TESTUT modèles B300 et B300S (Classe III)
Société Testut, 957 rue de l'Horlogerie, BP 11, 62401 Béthune, France

R76/1992-FR-98.03
Bascule électronique TESTUT modèle WSI1 (Classe III)
Société Testut, 957 rue de l'Horlogerie, BP 11, 62401 Béthune, France

▶ Issuing Authority / *Autorité de délivrance*

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

R76/1992-NL-98.16
Type PS60 (Class III)
Mettler-Toledo Inc., 1150 Dearborn Drive, Worthington, OH 43085-6712, USA

R76/1992-NL-98.17
Type EK-H (Class II)
A&D Instruments Ltd., Abingdon Science Park, Abingdon, Oxford OX14 3YS, United Kingdom

R76/1992-NL-98.18
Type 8530-Cougar (Class III)
Mettler-Toledo Inc., 1150 Dearborn Drive, Worthington, OH 43085-6712, USA

R76/1992-NL-98.19
Type KA-100.... (Class III or IIII)
Servo Balans International B.V., Jan Evertsenlaan 4, 2224 SV Katwijk, The Netherlands

R76/1992-NL-98.26 Rev. 1
Type ECOCELL R-220 (Class III)
Yamato Scale GmbH, Hanns-Martin-Schleyer Straße 13, D-47877 Willich, Germany

R76/1992-NL-98.28
OZ series (Class III)
Towa Meccs Corporation, 5-5 Hongo 3-Chome, Bunkyo, Tokyo 113-0033, Japan

R76/1992-NL-98.29
Types AB-S, GB-S and PB-S (Classes I, II and III)
Mettler-Toledo A.G., Im Langacher, 8606 Greifensee, Switzerland

▶ Issuing Authority / *Autorité de délivrance*

Gosstandart of Russian Federation, Russian Federation

R76/1992-RUS-98.01
Car weigher type M 8200A (Class III)
The scientific industrial manufacture "Metra Ltd.", 106 Lenin Prospect, Box 8128, Obninsk, region Kaluga, 249020, Russian Federation

R76/1992-RUS-98.02
Wagon weigher type M 8300-150 (Class III)
The scientific industrial manufacture "Metra Ltd.", 106 Lenin Prospect, Box 8128, Obninsk, region Kaluga, 249020, Russian Federation

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*

National Weights and Measures Laboratory (NWML), United Kingdom

R117/1995-GB-98.01
Fuel dispenser for motor vehicles, Gilbarco G-line (Class 0.5)
Gilbarco Limited, Crompton Close, Basildon, Essex SS14 3BA, United Kingdom

R117/1995-GB-98.02
Fuel dispenser for motor vehicles, Gilbarco Enterprise (Class 0.5)
Gilbarco Limited, Crompton Close, Basildon, Essex SS14 3BA, United Kingdom

▶ Issuing Authority / *Autorité de délivrance*

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

R117/1995-NL-98.02
Model Euro Premier (Class 0.5) with Bennet EPZ 75 combined pump, Tokheim Sofitan MA 26-5 meter and Eltomatic 01-08 pulser
Tokheim Europe B.V., Reaal 5C, 2353 TK Leiderdorp, The Netherlands

Report on BIML Activities

November 1997 – October 1998

Follow-up on the 32nd CIML meeting	• Editing and distribution of the "Decisions and Resolutions" • Editing and distribution of the minutes • Implementation of the decisions (see more detailed information below)
Presidential Council	• Organization of a meeting in Paris; reports on the various aspects of OIML activities of interest to the Council • Organization (in cooperation with Prof. Kochsiek) of a second short meeting in Braunschweig on the occasion of the International Seminar held in June • Multiple contacts with the CIML President and Vice-Presidents; meeting of the Presidium in Paris
Preparations for the 33rd CIML Meeting	• Papers and arrangements for the meeting in liaison with the Korean administration (see more detailed information below)
Development Council	• Editing and distribution of the minutes of the 1997 Rio meeting • Preparations for the Seoul meeting: report on activities up to 1998; provisional work program for 1998–2000, etc. • Liaison with ISO/DEVCO, UNIDO, WTO, UNCTAD, etc. • Contacts with national bodies specializing in assistance to developing countries (DAM, etc.)
OIML Policy	• Development and publication of the assessment document for the period 1995–1997 • Duplication and distribution of the initial and final "Birkeland report" • Conceptualization of a report presenting the main issues discussed by the Conference, Committee and Presidential Council over the last four years
Technical Committees and Subcommittees	• Inquiries for annual reports; information of the Presidential Council; report in the OIML Bulletin • Examination of the situation of certain TC's/SC's • Participation in the work of certain TC's/SC's (see participation in meetings, below) • Liaison between certain TC's/SC's and international and regional bodies with related activities • Editing and distribution of six draft Recommendations for CIML approval in 1998, and of two drafts for 1999 • Updating of the documents (State of progress, responsibility ..., etc.) related to TC/SC activities
Participation in OIML technical meetings	• TC 8/SC 7 (Vienna, November 1997) • TC 9 and TC 9/SC 3 (Gaithersburg, May 1998)

Certification	• Organization of a meeting of the OIML working group at the BIML in February 1998 • 2nd inquiry concerning the implementation and promotion of the Certificate System in OIML Member States • Registration of OIML certificates; information for Members • Follow-up on conformity assessment, quality management, certification, accreditation and related activities within other international and regional bodies (ISO/IEC, ILAC, EAL, UN/ECE, etc.)
Technical publications	• Implementation of the new design and layout of OIML International Recommendations and Documents on schedule as announced at the 32nd CIML meeting • Editing, layout and printing of 9 International Recommendations (4 approved in 1996, 5 in 1997) (approx. 1000 printed pages); editing, layout and preparations for printing of two International Documents
OIML Bulletin	• Production of 4 issues (approx. 240 pages) • Proof-reading and authors' approval of all articles before publication • Increase in variety of articles; more color photos; improvement in layout; new format for the address/publications listing leaflet
Communication	• Regular update of the information annexed to the Blue Brochure • Regular update of the OIML transparency presentation • Regular update and improvement of the OIML Web site • Creation of two posters on OIML/BIML activities • Conception of an "OIML Annual Report"
Liaisons with other institutions (including participation in meetings)	• Organization of JCGM and JCGM/WG 2 meetings at the BIML (November 1997) • ARSO General Assembly (Nairobi, January 1998) • Organization of a joint BIPM/ILAC/OIML meeting at the BIML (February 1998) • JCGM/WG 2 (April 1998, Geneva; September 1998, BIPM) • Participation in the WELMEC Seminar on "Enforcement", Douais, April 1998 • IEC/TC 62 on electrical medical equipment (Toronto, May 1998) • UN/ECE (Geneva, May 1998) • SIM technical seminar (NIST, June 1998) • Co-organization with the BIPM, IMEKO and PTB of the International Seminar on the "Role of metrology in economic and social development", Braunschweig, June 1998; publication of a report in the OIML Bulletin • ISO Workshop on MRA's (June 1998) • WTO TBT Committee (July and September 1998, Geneva) • ISO/DEVCO (September 1998) • ILAC General Assembly (October 1998, Sydney) • APLMF (October 1998, Seoul) • Other contacts with ISO (joint ISO/OIML publication on vehicle exhaust gas), EUROMET, COOMET, CECIP, SIM, etc.
Visits to and from OIML Members	• Australia, Belgium, China, Croatia, France, Germany, Kazakhstan, Kenya, Rep. of Korea, Mongolia, Netherlands, Russia, Slovenia, Spain, Switzerland, Chinese Taipei, United Kingdom, Uruguay, USA, Vietnam, Yugoslavia

Committee drafts received by the BIML, 1998.08.01–1998.11.30

Title	Language	CD n°	TC/SC	Country
Octave-band and fractional octave-band filters	E	3 CD	TC 13	Germany
Revision of OIML R 49 *Water Meters*	E	4 CD	TC 8/SC 5	UK
Revision of OIML D 5 *Principles for the establishment of hierarchy schemes for measuring instruments*	E	1 CD	TC 4	Slovakia
Revision of OIML R 16 *Test report format for sphygmomanometers*	E	2 CD	TC 18/SC 1	Austria

Nouvelles Publications OIML en français

Les versions françaises des Publications suivantes sont désormais disponibles:

- **R 81** Dispositifs et systèmes de mesure dynamique de liquides cryogéniques (comprend tables de masse volumique pour argon, hélium, hydrogène, azote et oxygène liquides)
- **R 85** Jaugeurs automatiques pour le mesurage des niveaux de liquide dans les réservoirs de stockage fixes
- **R 125** Systèmes de mesure de la masse des liquides dans les réservoirs
- **R 126** Éthylomètres
- **D 2** Unités de mesure légales

Russian - English - French - German - Spanish

Vocabulary of Basic and General Terms in Metrology (1998)

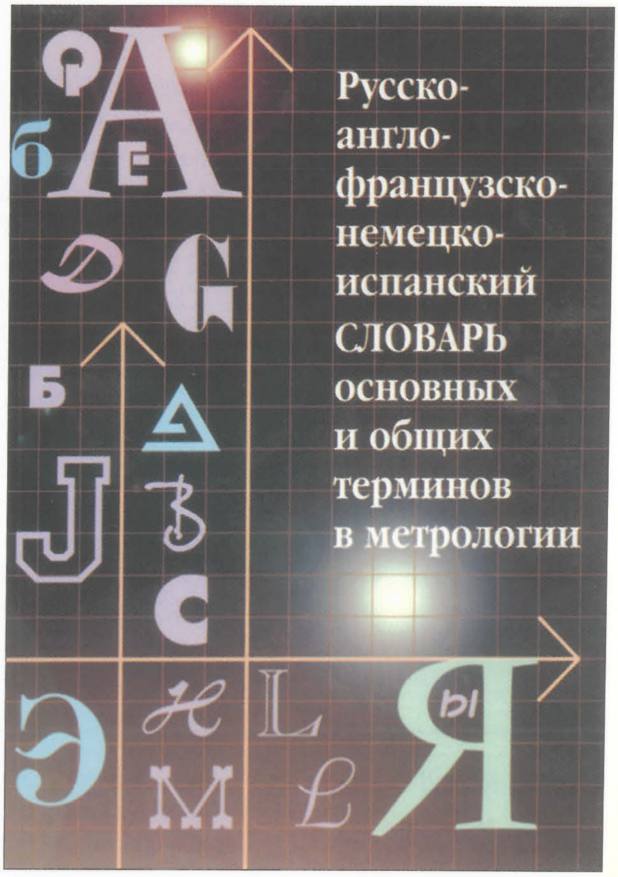
This Vocabulary, edited by Prof. Dr. Lev Issaev and published by the Moscow Publishing House of Standards, contains - for the first time - the basic and general metrological terms and definitions in five languages. Based on the English-French VIM, it consists of two parts:

Part 1 – *Six separate sections on Quantities and Units, Measurements, Measurement Results, Measuring Instruments, Characteristics of Measuring Instruments, and Measurement Standards. Presented in 2-columns, the left hand column contains term equivalents in five languages and the right hand column contains the translation of their definitions into Russian.*

Part 2 – *Convention du Mètre (in Russian, English and French), the Convention Establishing the OIML (in Russian), and the Russian Federation Law on Assurance of Measurement Uniformity (in Russian and English).*

Copies (cost: US $ 50 each) may be obtained from:

Publishing House of Standards
14, Kolodezny per.
107 076 Moscow, Russia
Tel. +7 095 268-47-32 Fax +7 095 268-47-24



Metrology '99
Cuba

Del 5 al 7 de octubre de 1999 celebraremos en La Habana, Cuba, el evento internacional METROLOGÍA 99, auspiciado por la Oficina Nacional de Normalización (NC) de la República de Cuba, la empresa MACNOR, S.A. y otras prestigiosas entidades nacionales, regionales e internacionales vinculadas a la ciencia de las mediciones.

METROLOGÍA 99 tiene como antecedentes eventos similares realizados en Cuba en 1990, 93 y 1996, es decir, que estas jornadas de trabajo en la esfera de la metrología se realizan cada tres años, siempre perfeccionando e innovando los resultados científicos, técnicos y comerciales que se han alcanzado en las citas anteriores.

Los eventos METROLOGÍA han logrado atraer la atención de la inmensa mayoría de los países de América Latina y el Caribe, de Europa como Alemania, España, la Federación Rusa e Italia y de países de distantes regiones como India, Japón y la República Popular China.

METROLOGÍA 99 está dirigido, de acuerdo con el interés concreto y al perfil específico de los participantes, a ejecutivos, expertos, especialistas y personal técnico en general relacionado directa o indirectamente a la Metrología; a organismos nacionales, regionales e internacionales de metrología; a empresas, universidades, centros e institutos científicos y tecnológicos, entidades comercializadoras públicas y privadas.

Los objectivos primordiales de METROLOGÍA 99 por tanto están encaminados a:

- Propiciar el intercambio de información científico-técnica, los conocimientos y experiencias en materia de metrología;
- Mostrar los avances alcanzados en la producción y comercialización de instrumentos de medición en todas las magnitudes físicas;
- Impulsar actividades internacionales y regionales de metrología.

METROLOGÍA 99 tendrá lugar en octubre de 1999, en fecha cercana al 14 de octubre "Día Mundial de la Normalización", que lo es también de los metrólogos y de todas las personas vinculadas a la ciencia de la mediciones, lo que permitirá que todos los que acudan al encuentro que estamos convocando, celebren por todo lo alto tan significativo día.

Si está interesado en recibir información más detallada, no dude en consultarnos:

¡ESPERAMOS TENER EL PLACER DE TENERLO ENTRE NOSOTROS!

Sponsored by the National Bureau of Standards of the Republic of Cuba, MACNOR S.A. and other prestigious national, regional and international bodies concerned with the science of measurements, METROLOGY '99 will be held in Havana, Cuba, on October 5–7, 1999.

METROLOGY '99 will take place in the wake of similar international events held in Cuba in 1990, 1993 and 1996, which have every three years contributed to enhance scientific, technical and commercial results.

These meetings have drawn the attention of most of the Latin American, Caribbean, European and Far Eastern countries, including Germany, Spain, Russia, Italy, India, Japan and the People's Republic of China.

Participating in METROLOGY '99 will be executives, experts, specialists and technical personnel directly or indirectly related to Metrology; National, regional and international metrological agencies and companies, universities, scientific and technological centers and institutions and State and privately owned marketing companies are also cordially invited to participate.

METROLOGY '99 will thus be mainly aimed at:

- Promoting the exchange of scientific and technical information, knowledge and experience in the field;
- Showing advances made in the manufacture and marketing of measuring instruments in all physical magnitudes;
- Boosting regional and international activities in the field.

METROLOGY '99 will be held on a date close to October 14 – World Standardization Day – which is also very significant for metrologists and other specialists involved in the science of measurements, a Day to observe and celebrate.

WE LOOK FORWARD TO WELCOMING YOU TO METROLOGY '99 !

For further information, do not hesitate to contact:

OFICINA NACIONAL DE NORMALIZACIÓN (NC)
Comisión Organizadora METROLOGÍA '99
Calle E No. 261 entre 11 y 13
La Habana 10400 - Cuba

Tel. (537) 30-0879, 30-0835 and 30-0022
Fax. (537) 33-8048 and 30-0022
e-mail:ncnorma@ceniai.inf.cu

meetings
OIML
réunions

February 1999

8–11	TC 8/SC 7 Gas metering	BRUSSELS, BELGIUM

March 1999

5	TC 13 Measuring instruments for acoustics and vibration	FRANKFURT, GERMANY

October 1999

TBA	OIML Development Council Meeting 34th CIML Meeting	TUNIS, TUNISIA

The OIML is pleased to welcome the following new:

CIML Member for Romania: Dr. D.G. Stoichiţoiu

Member State: South Africa

Corresponding Member: Madagascar

info

FLOW TIDINGS

1999 NEL 2002

The DTI's Programme for Flow Measurement is one of 15 Programmes covering industrial metrology in the UK.

NEL, which is coordinating and managing the Programme, acts as custodian of the National Standards for Flow Measurement and is located in East Kilbride, Scotland.

Each Flow Programme lasts three years; the next one will start on **1st October 1999**.

The Programme provides the maintenance of the UK standards facilities at NEL, the provision of traceability for the individual measurement components of mass, volume, time, temperature, pressure, etc. used in the facilities, the development of facilities to meet the changing needs of industry and the intercomparison of the standards with other facilities world-wide.

The activity of most direct interest to industry is research – defined as work of a generic nature which will improve the flow measurement process and lead to an increase in industry's efficiency, effectiveness and competitiveness.

For more information on the Programme for 1999–2002, and to submit ideas for consideration, contact:

Dr. W.C. Pursley
Tel. +44 (0)1355 272 551
Fax +44 (0)1355 272 626
E-mail: wpursley@nel.uk
Internet: www.nelflow.co.uk

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

Secretariat:
BUREAU INTERNATIONAL DE MÉTROLOGIE LÉGALE (BIML)
11, RUE TURGOT - 75009 PARIS - FRANCE

TEL: 33 (0)1 48 78 12 82 OR 33 (0)1 42 85 27 11
FAX: 33 (0)1 42 82 17 27
E-MAIL: biml@oiml.org
INTERNET: http://www.oiml.org

JANUARY 1999

This list of OIML publications is classified by subject and number. The following abbreviations are used:

R International Recommendation;
D International Document;
V Vocabulary;
P Miscellaneous Publication.

Publications are available in French and English in the form of separate documents, unless otherwise indicated. Prices are given in French Francs and do not include postage. "NC" indicates "no charge".

OIML publications are available either from the BIML (see address above) or from national sale points in the countries listed below (please contact the relevant CIML Member at the address given in this document).

National Sale Points:

▶ UNITED KINGDOM

Cette liste des publications OIML est classée par sujets et par numéros. Les abréviations suivantes sont utilisées:

R Recommandation Internationale;
D Document International;
V Vocabulaire;
P Autre Publication.

Ces publications sont disponibles en français et en anglais sous forme de fascicules séparés, sauf indication contraire. Les prix sont donnés en Francs Français et ne comprennent pas les frais d'expédition. "NC" signifie "gratuit".

Les publications OIML sont disponibles soit auprès du BIML (adresse ci-dessus), soit auprès des points de vente nationaux dans les pays mentionnés ci-dessous (contacter le Membre du CIML à l'adresse donnée dans ce document).

Points de Vente Nationaux:

▶ ROYAUME-UNI

ALGERIA

Le Directeur
Office National de Métrologie Légale
1, rue Kaddour Rahim
BP 415, 16040 Hussein Dey
Alger
Tel./Fax: 213-2 77 77 37
Telex: 65 599

AUSTRALIA

J. Birch
Executive Director
National Standards Commission
PO Box 282
North Ryde, NSW 1670
Tel.: 61-2-9888 3922
Fax: 61-2-9888 3033
E-mail: jbirch@nsc.gov.au
Telex: OTCD AA 100200
(Mail Box 6007:NSC001)

AUSTRIA

Arnold Leitner
Director of the Metrology Service
Gruppe Eichwesen
Bundesamt für Eich- und Vermessungswesen
Postfach 20, Arltgasse 35
A-1163 Wien
Tel.: 43-1-49 110 322
Fax: 43-1-49 208 75
E-mail: admin@bev-eich.gv.at

BELARUS

N. A. Kusakin
Chief of the Metrology Department
Standardization, Metrology and Certification Committee (Belstandart)
93 Starovilensky Trakt
Minsk, 220053
Tel.: 375-172-37 52 13
Fax: 375-172-37 25 88

BELGIUM

H. Voorhof
Conseiller Général
Service de la Métrologie
Ministère des Affaires Économiques
Administration de la Qualité et de la Sécurité
NG III, Bd E. Jacqmain 154
B-1000 Bruxelles
Tel.: 32-2-206 46 63
Fax: 32-2-206 57 41
E-mail: voorhof@pophost.eunet.be

BRAZIL

R. Luiz de Lima Guimarães
Director of Legal Metrology
Instituto Nacional de Metrologia, Normalização e Qualidade Industrial (INMETRO)
Avenida N. S. das Graças, No. 50
Xerém, Duque de Caxias
25250-020 Rio de Janeiro RJ
Tel.: 55-21-679 1407
Fax: 55-21-679 1761
E-mail: dimel@inmetro.gov.br

BULGARIA

Ivan Temniskov
Secrétaire Général
Comité de Normalisation et de Métrologie
21, rue du 6 Septembre
Sofia 1000
Tel.: 359-2-8591
Fax: 359-2-801 402
Telex: 22 570 DKS BG
E-mail: csm@techno-link.com

CAMEROON

H. Ela Essi
Sous-Directeur de la Métrologie
Direction des Prix et de la Métrologie
Ministère de l'Economie et des Finances
BP 501, Yaoundé
Tel.: 237-22-31 16
Fax: 237-20-79 47

CANADA

A. E. Johnston
President
Measurement Canada
Industry Canada
Main Building
Suite 2600
Tunney's Pasture
Ottawa
Ontario K1A OC9
Tel.: 1-613-952 06 55
Fax: 1-613-957 12 65
E-mail: johnston.alan@ic.gc.ca

CHINA

Li Chuanqing
Director General
State Bureau of Technical Supervision
4, Zhichunlu Haidian
P.O. Box 8010, Beijing 100088
Tel.: 86-10-6236 9419 or 86-10-6203 2424
Fax: 86-10-6203 2552 or 86-10-6203 1010
Telegram: 1918 Beijing

CUBA

Martin Antunez Ramirez
Director of Metrology
c/o Mr Alberto Marrero Terrero
Director, International Relations
National Bureau of Standards
Calle E No. 261 entre 11 y 13
Vedado, La Habana 10400
Ciudad de la Habana
Tel.: 53-7-30 00 22
Fax: 53-7-33 80 48
Telex: 512245
E-mail: ncnorma@ceniai.inf.cu

CYPRUS

G. Tsiartzazis
Controller of Weights and Measures
Ministry of Commerce, Industry and Tourism
Lefkosia
Tel.: 357-2-30 80 41
Fax: 357-2-37 51 20
Telex: 2283 MIN COMIND
Telegram: Mincommind Nicosia

CZECH REPUBLIC

Pavel Klenovský
Director General
Czech Metrological Institute
Okružni 31
63800 Brno
Tel.: 420-5-45 22 27 09
Fax: 420-5-45 22 27 28
E-mail: pklenovsky@cmi.cz

DENMARK

P. C. Johansen
Assistant Head
Secretariat for Metrology
Danish Agency for Trade and Industry
Tagensvej 137
DK-2200 Copenhagen N
Tel.: 45-35-86 86 86
Fax: 45-35-86 86 87
E-mail: poul.claudi-johansen@efs.dk

EGYPT

Ali A. El-Naggar
President
Egyptian Organization for Standardization and Quality Control
2 Latin America Street, Garden City
Cairo
Tel.: 20-2-354 97 20
Fax: 20-2-355 78 41
Telex: 93 296 EOS UN
Telegram: TAWHID

ETHIOPIA

Berhanu Werede
Quality and Standards Authority of Ethiopia
P.O. Box 2310
Addis Ababa
Tel.: 251-1-18 59 91
Fax: 251-1-61 31 77
E-mail: eas@telecom.net.et

FINLAND

Marja Leena Junttila (Mrs)
Director, Legal Metrology and
Articles of Precious Metals
Turvatekniikan Keskus
Safety Technology Authority
P.O. Box 123 (Lönnrotinkatu 37)
FIN-00181 Helsinki
Tel.: 358-9-40 580 3161
Fax: 358-9-6167 590
E-mail: ml.junttila@tukes.fi

FRANCE

J. F. Magana
Sous-Directeur de la Métrologie
Ministère de l'Économie, des Finances
et de l'Industrie
22, rue Monge
75005 Paris
Tel.: 33-(0)1-43 19 51 40
Fax: 33-(0)1-43 19 51 36
E-mail:
jean-francois.magana@industrie.gouv.fr

GERMANY

M. Kochsiek
Vice-President
Physikalisch-Technische Bundesanstalt
Bundesallee 100
D-38116 Braunschweig
Tel.: 49-531-592 20 00
Fax: 49-531-592 20 02
E-mail: manfred.kochsiek@ptb.de

GREECE

A. Dessis
Technical Officer
Directorate of Weights and Measures
Ministry of Commerce
Canning Sq.
10181 Athens
Tel.: 30-1-381 41 68
Fax: 30-1-384 26 42
Telex: 21 67 35 DRAG GR
and 21 52 82 YPEM GR

HUNGARY

P. Pákay
President
Országos Mérésügyi Hivatal
P.O. Box 919
H-1535 Budapest
Tel.: 36-1-356 77 22
Fax: 36-1-355 05 98
Telegram: HUNGMETER Budapest
E-mail: pakay@omh.hu

INDIA

P. A. Krishnamoorthy
Director, Legal Metrology
Ministry of Food and Consumer Affairs
12-A, Jamnagar House
Shahjahan Road
New Delhi 110 011
Tel.: 91-11-338 94 89
Fax: 91-11-338 53 22

INDONESIA

R. Simanullang
Director, Directorate of Metrology
Directorate General of Domestic Trade
Department of Industry and Trade
Jalan Pasteur No. 27
Bandung 40171
Tel.: 62-22-420 3597 and 62-22-420 7066
Fax: 62-22-420 7035
Telex: 28 176 BD

ISLAMIC REPUBLIC OF IRAN

The Director
Public and International Relations
Institute of Standards and Industrial
Research of Iran
P.O. Box 31585-163
Karaj
Tel.: 98-261-227 045
Fax: 98-261-225 015
Telex: 215442 SIAN IR

IRELAND

Tom Dempsey
Director
Legal Metrology Service
National Standards Authority of Ireland
Glasnevin
Dublin 9
Tel.: 353-1-808 23 00
Fax: 353-1-808 20 30
E-mail: legalmet@forbairt.ie

ISRAEL

T. Zarin
Controller of Weights and Measures
Ministry of Industry and Trade
30 Agron Street
Jerusalem 94190
Tel.: 972-2-622 06 79
Fax: 972-2-622 06 70

ITALY

A. Lirosi
Direttore Generale per l'Armonizzazione e
la Tutela del Mercato
Ministero dell'Industria Commercio
ed Artigianato
Ufficio Centrale Metrico
Via Antonio Bosio, 15
I-00161 Roma
Tel.: 39-06-841 68 25
Fax: 39-06-841 41 94
E-mail: micaØØ18@polig.ipzs.it

JAPAN

H. Imai
Director General
National Research Laboratory of
Metrology
1-4, Umezono 1-Chome, Tsukuba
Ibaraki 305-8563
Tel.: 81-298-54 41 49
Fax: 81-298-54 42 02
E-mail: kyouryokukan@nrlm.go.jp

KAZAKHSTAN

A. Sadikov
Director, Alma-Ata Standardization
and Metrology Centre
83 Altinsarin Avenue
Alma-Ata 480035
Tel.: 7-327-221 69 72
Fax: 7-327-221 48 45

KENYA

A. E. Ndegwa
Director of Weights and Measures
Weights and Measures Department
Ministry of Commerce and Industry
P.O. Box 41071
Nairobi
Tel.: 254-2-50 46 65/4
Fax: 254-2-50 46 33
Telegram: ASSIZERS, Nairobi

DEM. P. REP. OF KOREA

Kim Gwang Ho
Director, Bureau of Metrology
State Commission of Science and Technology
Zung Gu Yok, Seungli-Street
PO Box 140/Pyongyang
Tel.: 850-2-381 60 25
Fax: 850-2-381 45 37

REP. OF KOREA

Yoo-Jin Koh
Director, International Cooperation and Metrology Division
Standards and Metrology Department
Korean National Institute of Technology and Quality (KNITQ)
2, Joongang-dong, Kwachon
Kyunggi-do, 427-010
Tel.: 82-2-507 43 69 / 509 73 96-8
Fax: 82-2-503 79 77
E-mail: int_coop@mail.nitq.go.kr

MONACO

A. Veglia
Ingénieur au Centre Scientifique de Monaco
16, Boulevard de Suisse
MC-98000 Monte Carlo
Tel.: 33-93-30 33 71

MOROCCO

Abdellah Nejjar
Directeur de la Normalisation et de la Promotion de la Qualité
Ministère de l'Industrie, du Commerce et de l'Artisanat
Angle Avenue Al Filao et Rue Dadi
Secteur 21
Hay Riad - Rabat
Tel.: 212-7-71 17 71 or ...72 or ...73
Fax: 212-7-71 17 98
E-mail: dqn@mcinet.gov.ma

NETHERLANDS

G.J. Faber
c/o Nederlands Meetinstituut B.V.
Dept. V-JZ
PO Box 654
2600 AR Delft
Tel.: 31-15-2691 664
Fax: 31-15-2850 507
E-mail: gengler@nmi.nl

NORWAY

H. Kildal
Director General
Norwegian Metrology and Accreditation Service (Justervesenet)
Fetveien 99
2007 Kjeller
Tel.: 47-64-84 84 84
Fax: 47-64-84 84 85
E-mail: helge.kildal@justervesenet.dep.telemax.no

PAKISTAN

M. Asad Hasan
Director
Pakistan Standards Institution
39-Garden Road
Saddar
Karachi-74400
Tel.: 92-21-772 95 27
Fax: 92-21-772 81 24
Telegram: PEYASAI

POLAND

Krzysztof Mordziński
President
Central Office of Measures
ul. Elektoralna 2
P.O. Box P-10
PL 00-950 Warszawa
Tel.: 48-22-620 07 47
Fax: 48-22-620 83 78

PORTUGAL

J. N. Cartaxo Reis
Director Serviço de Metrologia Legal
Instituto Português da Qualidade
Rua C à Avenida dos Três Vales
2825 Monte da Caparica
Tel.: 351-1-294 81 96
Fax: 351-1-294 81 88

ROMANIA

D.G. Stoichiţoiu
Directeur Général
Bureau Roumain de Métrologie Légale
21, Boulevard Nicolae Balcescu
Sector 1
70112 Bucarest
Tel.: 40-1-313 16 54 and 313 16 05
Fax: 40-1-312 05 01

RUSSIAN FEDERATION

L. K. Issaev
Deputy Director
VNIIMS
Leninsky Prospect 9
117049 Moscow
Tel.: 7-095-236 75 60
Fax: 7-095 237 60 32
E-mail: lev_issaev@gost.ru

SAUDI ARABIA

Khaled Y. Al-Khalaf
Director General
Saudi Arabian Standards Organization
P.O. Box 3437
11471 Riyadh
Tel.: 966-1-452 00 00
Fax: 966-1-452 00 86
Telex: 40 16 10 saso sj

SLOVAKIA

Lubomír Sutek
President
Úrad pre Normalizáciu Metrológiu a Skúšobníctvo SR
Štefanovičova 3
814 39 Bratislava
Tel.: 421-7-391 085
Fax: 421-7-391 050
E-mail: sutek@normoff.gov.sk

SLOVENIA

Vasja Hrovat
Adviser to the Director
Ministrstvo za znanost in tehnologijo
Urad za standardizacijo in meroslovje
Kotnikova 6
1000 Ljubljana
Tel.: 386-61-178 30 31
Fax: 386-61-178 31 96
E-mail: vasja@usm.mzt.si

SOUTH AFRICA

Brian Beard
Manager, Trade Metrology
South African Bureau of Standards
1 Dr. Lategan Road, Groenkloof
Private Bag X191, Pretoria 0001
Tel.: 27-12-428 7001
Fax: 27-12-428 6552
E-mail: beardbe@mail.sabs.co.za

SPAIN

The Director
Centro Español de Metrología
c/ del Alfar 2
28760 Tres Cantos (Madrid)
Tel.: 34-1-807 47 00
Fax: 34-1-807 48 07
E-mail: mmpena@mfom.es

SRI LANKA

H. L. R. W. Madanayake
Deputy Commissioner of Internal Trade
Measurement Standards
and Services Division
Department of Internal Trade
101, Park Road
Colombo 5
Tel.: 94-1-83 261
Telex: 21908 COMECE CF

SWEDEN

Sven Nyström
Chief Legal Adviser - Head,
Department of Legal and Public
Administration
SWEDAC
Box 2231
S-103 15 Stockholm
Tel.: 46-8-402 00 72
Fax: 46-8-791 89 29
E-mail: sven.nystrom@swedac.se

SWITZERLAND

B. Vaucher
Deputy Director
Federal Office of Metrology
Lindenweg 50
CH-3003 Bern-Wabern
Tel.: 41-31-323 32 02
Fax: 41-31-323 32 10
E-mail: bruno.vaucher@eam.admin.ch

TANZANIA

A. H. M. Tukai
Commissioner for Weights and Measures
Weights and Measures Bureau
Ministry of Industries and Trade
P.O. Box 313
Dar es Salaam
Tel.: 864046/864808
Telex: 41 689 INDTRA

THE FORMER YUGOSLAVE REPUBLIC OF MACEDONIA

Grkov Zoran
Assistant to the Minister
Bureau of Standardization and Metrology
Ministry of Economy
Samoilova 10
91000 Skopje
Tel.: 389-91-13 11 02
Fax: 389-91-11 02 63

TUNISIA

Ghaïet El-Mouna Annabi (Mrs)
Directeur de la Qualité et de la Protection
du Consommateur
Direction Générale de la Concurrence et du
Commerce Intérieur
Ministère du Commerce
12, Rue de l'Arabie Saoudite
1002 Tunis
Tel.: 216-1-780 336 and 216-1-289 540
Fax: 216-1-780 336

UNITED KINGDOM

S. Bennett
Chief Executive
National Weights and Measures Laboratory
Stanton Avenue
Teddington, Middlesex TW11 OJZ
Tel.: 44-181-943 72 72
Fax: 44-181-943 72 70
Telex: 9312131043 (WM G)
E-mail: seton.bennett@nwml.dti.gov.uk

UNITED STATES OF AMERICA

S. E. Chappell
Chief, Technical Standards Activities
Program, 215
Office of Standards Services
National Institute of Standards
and Technology
Building 820, Room 162
Gaithersburg, Maryland 20899
Tel.: 1-301-975 40 24
Fax: 1-301-926 15 59
Telex: 197674 NBS UT
E-mail: chappell@nist.gov

YUGOSLAVIA

Z. M. Marković
Deputy Director
Federal Bureau of Measures
and Precious Metals
Mike Alasa 14
11000 Beograd
Tel.: 381-11-328 27 36
Fax: 381-11-18 16 68
E-mail: z.m.markovic@gov.yu

ZAMBIA

Fredrick M. Sinyangwe
Deputy Superintendent Assizer
Assize Department
Weights and Measures Office
Ministry of Commerce and Industry
P.O. Box 30 989
Lusaka
Tel.: 260-1-21 60 62
Fax: 260-1-22 22 94
Telegram: Assize, LUSAKA
Telex: 45630 COMIND ZA

CIML HONORARY MEMBERS

Mr. K. Birkeland (Norway) .... CIML Immediate Past President
Mr. V. Ermakov (Russian Federation) .... Former CIML Vice-President
Mr. A. Perlstain (Switzerland) .... Former Member of the Presidential Council
Mr. W. Mühe (Germany) .... Former CIML Vice-President
Mr. H. W. Liers (Germany) .... Former Member of the Presidential Council

ALBANIA
The Director
National Directorate
Drejtoria Kombëtare e Metrologjisë
dhe e Kalibrimit (DKMK)
Rruga "Sami Frashëri", Nr.33
Tirana

ARGENTINA
The Director
Ministerio de Economia y Obras
y Servicios Publicos
Direccion Nacional de Commercio Interior
Julio A. Roca 651
Pise 4° - Sector 1 - (CP 1322)
Buenos Aires

BAHRAIN
The Acting Director
Directorate of Standards and Metrology
(BSMD), Ministry of Commerce
P.O. Box 5479
Manama

BANGLADESH
The Director General
Bangladesh Standards
and Testing Institution
116-A Tejgaon Industrial Area
Dhaka 1208

BARBADOS
The Director
Barbados National Standards Institution
Culloden Road
St. Michael
Barbados W.I.

BOSNIA AND HERZEGOVINA
The General Director
Institute for Standardization, Metrology
and Patents of Bosnia and Herzegovina
BIH, 71000 Sarajevo
Dubrovačka 6

BOTSWANA
The Permanent Secretary
Division of Weights and Measures
Department of Commerce
and Consumer Affairs
Private Bag 48
Gaborone

COLOMBIA
Superintendencia de Industria y Comercio
Carrera 13 No. 27-00
Piso 10
Santafé de Bogotá, D.C.

COSTA RICA
Oficina Nacional de Normas y Unidades
de Medida
Ministerio de Economia y Comercio
Apartado 10 216
San Jose

CROATIA
General Director
State Office for Standardization
and Metrology
Ulica grada Vukovara 78
HR-10 000 Zagreb

ECUADOR
The General Director
Instituto Ecuatoriano de Normalizacion
Baquerizo Moreno No. 454 y Almagro
Casilla 17-01-3999
Quito

ESTONIA
The Director General
National Standards Board of Estonia
Aru 10
EE-0003 Tallinn

FIJI
The Chief Inspector of Weights and
Measures
Ministry of Economic Development,
Planning and Tourism
Government Buildings
P.O. Box 2118
Suva

GUATEMALA
Departemento de Metrologia
Comision Guatemalteca de Normas,
Coguanor
Ministerio de Economia
8a Av. 10-43, Z.I.
Ciudad de Guatemala, Guatemala, C.A.

HONG KONG, CHINA
Commissioner of Customs and Excise
Customs and Excise Department
Units 1201-7
Nan Fung Commercial Centre
19 Lam Lok Street
Kowloon Bay

ICELAND
The Director
Icelandic Bureau of Legal Metrology
Löggildingarstofa
Sídumúli 13
108 Reykjavik

JORDAN
Jordanian Institution for Standardization
and Metrology
P.O. Box 941287
Amman 11194

KUWAIT
The Under Secretary
Ministry of Commerce and Industry
Department of Standards and Metrology
Post Box No 2944
Kuwait

LATVIA

Latvian National Centre of Standardization and Metrology
157, Kr. Valdemara St.
LV-1013 Riga

LITHUANIA

The Director
Lithuanian Standards Board
T. Kosciuskos g.30
2600 Vilnius

LUXEMBURG

Le Préposé du Service de Métrologie
Administration des Contributions
Zone commerciale et artisanale
Cellule A2
rue J.F. Kennedy
L-7327 Steinsel

MADAGASCAR

Direction de la Normalisation et de la Qualité
Direction Générale du Commerce et de la Consommation
Ministère du Commerce et de la Consommation
BP 1316
Antananarivo 101

MALAWI

The Trade Metrology Manager
Malawi Bureau of Standards
Trade Metrology Division
P.O. Box 156
Lilongwe

MALAYSIA

The Director of Standards
Standards and Industrial Research Institute of Malaysia
P.O. Box 7035
40911 Shah Alam
Selangor Darul Ehsan

MAURITIUS

The Permanent Secretary
Ministry of Trade and Shipping
(Division of Weights and Measures)
New Government Centre
Port Louis

MEXICO

Direccion General de Normas
Secretaria de Comercio y Fomento Industrial
Sistema Nacional de Calibracion
Ave. Puente de Tecamachalco no. 6
Planta Baja
Lomas de Tecamachalco, Seccion Fuentes
53950 Naucalpan de Juarez

MOLDOVA

The Director General
Departamentul Standarde, Metrologie şi supraveghere tehnică al Republicii Moldova
str. S. Lazo, 48
277004, or. Chişinău

MONGOLIA

The Director General
Mongolian National Center for Standardization and Metrology
PO Box 48
Ulaanbaatar 211051

MOZAMBIQUE

The Director
Instituto Nacional de Normalizaçao e Qualidade
Av. 25 de Setembro n° 1179, 2° andar
Maputo

NEPAL

The Chief Inspector
Nepal Bureau of Standards and Metrology
P.B. 985, Sundhara
Kathmandu

NEW ZEALAND

The Manager
Trade Measurement Unit
Ministry of Consumer Affairs
P.O. Box 1473
Wellington

OMAN

The General Director for Specifications and Measurements
Ministry of Commerce and Industry
P.O. Box 550
Muscat

PANAMA

The Director
Comision Panamena de Normas Industriales y Tecnicas
Ministerio de Comercio e Industrias
Apartado 9658
Panama 4

PAPUA NEW GUINEA

The Director General
National Institute of Standards and Industrial Technology
P.O. Box 3042
Boroko

PERU

The Director General
INDECOPI
Instituto Nacional de Defensa de la Competencia y de la Proteccion de la Propiedad Intelectual
Prolong. Guardia Civil No.400
Esq. con Av. Canada, San Borja
Lima 41

PHILIPPINES

Bureau of Product Standards
Department of Trade and Industry
3rd floor, DTI Building
361 Sen. Gil J. Puyat Avenue
Makati, Metro Manila
Philippines 3117

SEYCHELLES

The Director
Seychelles Bureau of Standards
P.O. Box 648
Victoria

SINGAPORE

Weights and Measures Office
Ministry of Trade and Industry
6 Bright Hill Drive
Singapore 57 95 98

SYRIA

The General Director
The Syrian Arab Organization
for Standardization and Metrology
P.O. Box 11836
Damascus

CHINESE TAIPEI

The Director General
National Bureau of Standards
Ministry of Economic Affairs
3F, 185 Hsinhai Road
Taipei 106, Taiwan

THAILAND

The Director General
Department of Commercial Registration
Ministry of Commerce
Maharaj Road
Bangkok 10200

TRINIDAD AND TOBAGO

The Director
Trinidad and Tobago Bureau of Standards
Century Drive, Trincity Industrial Estate
P.O. Box 467
Macoya, Tunapuna, Trinidad, W.I

TURKEY

The General Director
Sanayi ve Ticaret Bakanligi
Ölçüler ve Standardlar Genel
Müdürlügü
06100 Tandoğan
Ankara

UKRAINE

The President
Derjstandard of Ukraine
vul. Gorkogo 174
252650 KIEV-6

URUGUAY

Gerencia de Metrología Legal
Avenida Italia 6201, CP. 11500
Montevideo

S. R. VIETNAM

Directorate for Standards
and Quality (STAMEQ)
70 Tran Hung Dao St.
Hanoï

General
Généralités

R 34 (1979–*1974*) .... 60 FRF
Accuracy classes of measuring instruments
Classes de précision des instruments de mesurage

R 42 (1981–*1977*) .... 50 FRF
Metal stamps for verification officers
Poinçons de métal pour Agents de vérification

D 1 (1975) .... 50 FRF
Law on metrology
Loi de métrologie

D 2 (1998) .... 80 FRF
Legal units of measurement
Unités de mesure légales

D 3 (1979) .... 60 FRF
Legal qualification of measuring instruments
Qualification légale des instruments de mesurage

D 5 (1982) .... 60 FRF
Principles for the establishment of hierarchy schemes for measuring instruments
Principes pour l'établissement des schémas de hiérarchie des instruments de mesure

D 9 (1984) .... 60 FRF
Principles of metrological supervision
Principes de la surveillance métrologique

D 12 (1986) .... 50 FRF
Fields of use of measuring instruments subject to verification
Domaines d'utilisation des instruments de mesure assujettis à la vérification

D 13 (1986) .... 50 FRF
Guidelines for bi- or multilateral arrangements on the recognition of: test results - pattern approvals - verifications
Conseils pour les arrangements bi- ou multilatéraux de reconnaissance des: résultats d'essais - approbations de modèles - vérifications

D 14 (1989) .... 60 FRF
Training of legal metrology personnel - Qualification - Training programmes
Formation du personnel en métrologie légale - Qualification - Programmes d'étude

D 15 (1986) .... 80 FRF
Principles of selection of characteristics for the examination of measuring instruments
Principes du choix des caractéristiques pour l'examen des instruments de mesure usuels

D 16 (1986) .... 80 FRF
Principles of assurance of metrological control
Principes d'assurance du contrôle métrologique

D 19 (1988) .... 80 FRF
Pattern evaluation and pattern approval
Essai de modèle et approbation de modèle

D 20 (1988) .... 80 FRF
Initial and subsequent verification of measuring instruments and processes
Vérifications primitive et ultérieure des instruments et processus de mesure

V 1 (1978) .... 100 FRF
Vocabulary of legal metrology (bilingual French-English)
Vocabulaire de métrologie légale (bilingue français-anglais)

V 2 (1993) .... 200 FRF
International vocabulary of basic and general terms in metrology (bilingual French-English)
Vocabulaire international des termes fondamentaux et généraux de métrologie (bilingue français- anglais)

P 1 (1991) .... 60 FRF
OIML Certificate System for Measuring Instruments
Système de Certificats OIML pour les Instruments de Mesure

P 2 (1987) .... 100 FRF
Metrology training - Synthesis and bibliography (bilingual French-English)
Formation en métrologie - Synthèse et bibliographie (bilingue français-anglais)

P 3-1 (1996) .... 400 FRF
Legal metrology in OIML Member States
Métrologie légale dans les États Membres de l'OIML

P 3-2 (1996) .... 300 FRF
Legal metrology in OIML Corresponding Members
Métrologie légale dans les Membres Correspondants de l'OIML

P 9 (1992) .... 100 FRF
Guidelines for the establishment of simplified metrology regulations

P 17 (1995) .... 300 FRF
Guide to the expression of uncertainty in measurement
Guide pour l'expression de l'incertitude de mesure

Measurement standards and verification equipment
Étalons et équipement de vérification

D 6 (1983) .... 60 FRF
Documentation for measurement standards and calibration devices
Documentation pour les étalons et les dispositifs d'étalonnage

D 8 (1984) .... 60 FRF
Principles concerning choice, official recognition, use and conservation of measurement standards
Principes concernant le choix, la reconnaissance officielle, l'utilisation et la conservation des étalons

D 10 (1984) .... 50 FRF
Guidelines for the determination of recalibration intervals of measuring equipment used in testing laboratories
Conseils pour la détermination des intervalles de réétalonnage des équipements de mesure utilisés dans les laboratoires d'essais

D 18 (1987) .... 50 FRF
General principles of the use of certified reference materials in measurements
Principes généraux d'utilisation des matériaux de référence certifiés dans les mesurages

D 23 (1993) .... 80 FRF
Principles of metrological control of equipment used for verification
Principes du contrôle métrologique des équipements utilisés pour la vérification

P 4 (1986–*1981*) .... 100 FRF
Verification equipment for National Metrology Services
Équipement d'un Service national de métrologie

P 6 (1987) .... 100 FRF
Suppliers of verification equipment (bilingual French-English)
Fournisseurs d'équipement de vérification (bilingue français-anglais)

P 7 (1989) .... 100 FRF
Planning of metrology and testing laboratories
Planification de laboratoires de métrologie et d'essais

P 15 (1989) .... 100 FRF
Guide to calibration

Mass and density
Masses et masses volumiques

R 15 (1974–*1970*) .... 80 FRF
Instruments for measuring the hectolitre mass of cereals
Instruments de mesure de la masse à l'hectolitre des céréales

R 22 (1975) .... 150 FRF
International alcoholometric tables (trilingual French-English-Spanish version)
Tables alcoométriques internationales (version trilingue français-anglais-espagnol)

R 33 (1979–*1973*) .... 50 FRF
Conventional value of the result of weighing in air
Valeur conventionnelle du résultat des pesées dans l'air

R 44 (1985) .... 50 FRF
Alcoholometers and alcohol hydrometers and thermometers for use in alcoholometry
Alcoomètres et aréomètres pour alcool et thermomètres utilisés en alcoométrie

R 47 (1979–*1978*) .... 60 FRF
Standard weights for testing of high capacity weighing machines
Poids étalons pour le contrôle des instruments de pesage de portée élevée

R 50-1 (1997) .... 150 FRF
Continuous totalizing automatic weighing instruments (Belt weighers). Part 1: Metrological and technical requirements - Tests
Instruments de pesage totalisateurs continus à fonctionnement automatique (peseuses sur bande) Partie 1: Exigences métrologiques et techniques - Essais

R 50-2 (1997) .... 200 FRF
Continuous totalizing automatic weighing instruments (Belt weighers). Part 2: Test report format
Instruments de pesage totalisateurs continus à fonctionnement automatique (peseuses sur bande) Partie 2: Format du rapport d'essai

R 51-1 (1996) .... 100 FRF
Automatic catchweighing instruments. Part 1: Metrological and technical requirements - Tests
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique. Partie 1: Exigences métrologiques et techniques - Essais

R 51-2 (1996) .... 300 FRF
Automatic catchweighing instruments. Part 2: Test report format
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique. Partie 2: Format du rapport d'essai

R 52 (1980) .... 50 FRF
Hexagonal weights, ordinary accuracy class from 100 g to 50 kg
Poids hexagonaux de classe de précision ordinaire, de 100 g à 50 kg

R 60 (1991) .... 80 FRF
Metrological regulation for load cells
Réglementation métrologique des cellules de pesée
Annex (1993) .... 80 FRF
Test report format for the evaluation of load cells
Format du rapport d'essai des cellules de pesée

R 61-1 (1996) .... 150 FRF
Automatic gravimetric filling instruments. Part 1: Metrological and technical requirements - Tests
Doseuses pondérales à fonctionnement automatique. Partie 1: Exigences métrologiques et techniques - Essais

R 61-2 (1996) .... 250 FRF
Automatic gravimetric filling instruments. Part 2: Test report format
Doseuses pondérales à fonctionnement automatique. Partie 2: Format du rapport d'essai

R 74 (1993) .... 80 FRF
Electronic weighing instruments
Instruments de pesage électroniques

R 76-1 (1992) .... 300 FRF
Nonautomatic weighing instruments. Part 1: Metrological and technical requirements - Tests
Instruments de pesage à fonctionnement non automatique. Partie 1: Exigences métrologiques et techniques - Essais
Amendment No. 1 (1994) .... NC

R 76-2 (1993) .... 200 FRF
Nonautomatic weighing instruments. Part 2: Pattern evaluation report
Instruments de pesage à fonctionnement non automatique. Partie 2: Rapport d'essai de modèle
Amendment No. 1 (1995) .... NC

R 106-1 (1997) .... 150 FRF
Automatic rail-weighbridges. Part 1: Metrological and technical requirements - Tests
Ponts-bascules ferroviaires à fonctionnement automatique. Partie 1: Exigences métrologiques et techniques - Essais

R 106-2 (1997) .... 250 FRF
Automatic rail-weighbridges. Part 2: Test report format
Ponts-bascules ferroviaires à fonctionnement automatique. Partie 2: Format du rapport d'essai

R 107-1 (1997) .... 150 FRF
Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers). Part 1: Metrological and technical requirements - Tests
Instruments de pesage totalisateurs discontinus à fonctionnement automatique (peseuses totalisatrices à trémie) Partie 1: Exigences métrologiques et techniques - Essais

R 107-2 (1997) .... 300 FRF
Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers). Part 2: Test report format
Instruments de pesage totalisateurs discontinus à fonctionnement automatique (peseuses totalisatrices à trémie) Partie 2: Format du rapport d'essai

R 111 (1994) .... 80 FRF
Weights of classes E_1, E_2, F_1, F_2, M_1, M_2, M_3
Poids des classes E_1, E_2, F_1, F_2, M_1, M_2, M_3

P 5 (1992) .... 100 FRF
Mobile equipment for the verification of road weighbridges (bilingual French-English)
Équipement mobile pour la vérification des ponts-bascules routiers (bilingue français-anglais)

P 8 (1987) .... 100 FRF
Density measurement
Mesure de la masse volumique

Length and speed
Longueurs et vitesses

R 21 (1975-1973) .... 60 FRF
Taximeters
Taximètres

R 24 (1975-1973) .... 50 FRF
Standard one metre bar for verification officers
Mètre étalon rigide pour Agents de vérification

R 30 (1981) .... 60 FRF
End standards of length (gauge blocks)
Mesures de longueur à bouts plans (cales étalons)

R 35 (1985) .... 80 FRF
Material measures of length for general use
Mesures matérialisées de longueur pour usages généraux

R 55 (1981) .... 50 FRF
Speedometers, mechanical odometers and chronotachographs for motor vehicles. Metrological regulations
Compteurs de vitesse, compteurs mécaniques de distance et chronotachygraphes des véhicules automobiles. Réglementation métrologique

R 66 (1985) .... 60 FRF
Length measuring instruments
Instruments mesureurs de longueurs

R 91 (1990) .... 60 FRF
Radar equipment for the measurement of the speed of vehicles
Cinémomètres radar pour la mesure de la vitesse des véhicules

R 98 (1991) .... 60 FRF
High-precision line measures of length
Mesures matérialisées de longueur à traits de haute précision

Liquid measurement
Mesurage des liquides

R 4 (1972–*1970*) .... 50 FRF
Volumetric flasks (one mark) in glass
Fioles jaugées à un trait en verre

R 29 (1979–*1973*) .... 50 FRF
Capacity serving measures
Mesures de capacité de service

R 40 (1981–*1977*) .... 60 FRF
Standard graduated pipettes for verification officers
Pipettes graduées étalons pour Agents de vérification

R 41 (1981–*1977*) .... 60 FRF
Standard burettes for verification officers
Burettes étalons pour Agents de vérification

R 43 (1981–*1977*) .... 60 FRF
Standard graduated glass flasks for verification officers
Fioles étalons graduées en verre pour Agents de vérification

R 45 (1980–*1977*) .... 50 FRF
Casks and barrels
Tonneaux et futailles

R 49 .... being revised - *en cours de révision*
Water meters intended for the metering of cold water
Compteurs d'eau destinés au mesurage de l'eau froide

R 63 (1994) .... 50 FRF
Petroleum measurement tables
Tables de mesure du pétrole

R 71 (1985) .... 80 FRF
Fixed storage tanks. General requirements
Réservoirs de stockage fixes. Prescriptions générales

R 72 (1985) .... 60 FRF
Hot water meters
Compteurs d'eau destinés au mesurage de l'eau chaude

R 80 (1989) .... 100 FRF
Road and rail tankers
Camions et wagons-citernes

R 81 (1998) .... 150 FRF
Dynamic measuring devices and systems for cryogenic liquids (including tables of density for liquid argon, helium, hydrogen, nitrogen and oxygen)
Dispositifs et systèmes de mesure dynamique de liquides cryogéniques (comprend tables de masse volumique pour argon, hélium, hydrogène, azote et oxygène liquides)

R 85 (1998) .... 150 FRF
Automatic level gauges for measuring the level of liquid in fixed storage tanks
Jaugeurs automatiques pour le mesurage des niveaux de liquide dans les réservoirs de stockage fixes

R 86 (1989) .... 50 FRF
Drum meters for alcohol and their supplementary devices
Compteurs à tambour pour alcool et leurs dispositifs complémentaires

R 95 (1990) .... 60 FRF
Ships' tanks - General requirements
Bateaux-citernes - Prescriptions générales

R 96 (1990) .... 50 FRF
Measuring container bottles
Bouteilles récipients-mesures

R 105 (1993) .... 100 FRF
Direct mass flow measuring systems for quantities of liquids
Ensembles de mesurage massiques directs de quantités de liquides
Annex (1995) .... 80 FRF
Test report format
Format du rapport d'essai

R 117 (1995) .... 400 FRF
Measuring systems for liquids other than water
Ensembles de mesurage de liquides autres que l'eau

R 118 (1995) .... 100 FRF
Testing procedures and test report format for pattern evaluation of fuel dispensers for motor vehicles
Procédures d'essai et format du rapport d'essai des modèles de distributeurs de carburant pour véhicules à moteur

R 119 (1996) .... 80 FRF
Pipe provers for testing measuring systems for liquids other than water
Tubes étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

R 120 (1996) .... 100 FRF
Standard capacity measures for testing measuring systems for liquids other than water
Mesures de capacité étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

R 125 (1998) .... 100 FRF
Measuring systems for the mass of liquids in tanks
Systèmes de mesure de la masse des liquides dans les réservoirs

D 4 (1981) .... 50 FRF
Installation and storage conditions for cold water meters
Conditions d'installation et de stockage des compteurs d'eau froide

D 7 (1984) .... 80 FRF
The evaluation of flow standards and facilities used for testing water meters
Évaluation des étalons de débitmétrie et des dispositifs utilisés pour l'essai des compteurs d'eau

D 25 (1996) .... 60 FRF
Vortex meters used in measuring systems for fluids
Compteurs à vortex utilisés dans les ensembles de mesurage de fluides

D 26 .... being printed - *en cours de publication*
Glass delivery measures – Automatic pipettes
Mesures en verre à délivrer – Pipettes automatiques

Gas measurement (1)
Mesurage des gaz

R 6 (1989) .... 80 FRF
General provisions for gas volume meters
Dispositions générales pour les compteurs de volume de gaz

R 31 (1995) .... 80 FRF
Diaphragm gas meters
Compteurs de gaz à parois déformables

R 32 (1989) .... 60 FRF
Rotary piston gas meters and turbine gas meters
Compteurs de volume de gaz à pistons rotatifs et compteurs de volume de gaz à turbine

Pressure (2)
Pressions

R 23 (1975–1973) .... 60 FRF
Tyre pressure gauges for motor vehicles
Manomètres pour pneumatiques de véhicules automobiles

R 53 (1982) .... 60 FRF
Metrological characteristics of elastic sensing elements used for measurement of pressure. Determination methods
Caractéristiques métrologiques des éléments récepteurs élastiques utilisés pour le mesurage de la pression. Méthodes de leur détermination

R 97 (1990) .... 60 FRF
Barometers
Baromètres

R 101 .... being printed - *en cours d'impression*
Indicating and recording pressure gauges, vacuum gauges and pressure vacuum gauges with elastic sensing elements (ordinary instruments)
Manomètres, vacuomètres et manovacuomètres indicateurs et enregistreurs à élément récepteur élastique (instruments usuels)

R 109 .... being printed - *en cours d'impression*
Pressure gauges and vacuum gauges with elastic sensing elements (standard instruments)
Manomètres et vacuomètres à élément récepteur élastique (instruments étalons)

R 110 (1994) .... 80 FRF
Pressure balances
Manomètres à piston

Temperature (2)
Températures

R 18 (1989) .... 60 FRF
Visual disappearing filament pyrometers
Pyromètres optiques à filament disparaissant

R 48 (1980–1978) .... 50 FRF
Tungsten ribbon lamps for calibration of optical pyrometers
Lampes à ruban de tungstène pour l'étalonnage des pyromètres optiques

(1) See also "Liquid measurement" D 25 – *Voir aussi "Mesurage des liquides" D 25*
(2) See also "Medical instruments" – *Voir aussi "Instruments médicaux"*

R 75 (1988) .... 60 FRF
Heat meters
Compteurs d'énergie thermique

R 84 (1989) .... 60 FRF
Resistance-thermometer sensors made of platinum, copper or nickel (for industrial and commercial use)
Capteurs à résistance thermométrique de platine, de cuivre ou de nickel (à usages techniques et commerciaux)

D 24 (1996) .... 60 FRF
Total radiation pyrometers
Pyromètres à radiation totale

P 16 (1991) .... 100 FRF
Guide to practical temperature measurements

Electricity
Electricité

R 46 .... being revised - *en cours de révision*
Active electrical energy meters for direct connection of class 2
Compteurs d'énergie électrique active à branchement direct de la classe 2

D 11 (1994) .... 80 FRF
General requirements for electronic measuring instruments
Exigences générales pour les instruments de mesure électroniques

Acoustics and vibration
Acoustique et vibrations

R 58 (1998) .... 80 FRF
Sound level meters
Sonomètres

R 88 (1998) .... 80 FRF
Integrating-averaging sound level meters
Sonomètres intégrateurs-moyenneurs

R 102 (1992) .... 50 FRF
Sound calibrators
Calibreurs acoustiques

Annex (1995) .... 80 FRF
Test methods for pattern evaluation and test report format
Méthodes d'essai de modèle et format du rapport d'essai

R 103 (1992) .... 60 FRF
Measuring instrumentation for human response to vibration
Appareillage de mesure pour la réponse des individus aux vibrations

R 104 (1993) .... 60 FRF
Pure-tone audiometers
Audiomètres à sons purs

Annex F (1997) .... 100 FRF
Test report format
Format du rapport d'essai

Environment
Environnement

R 82 (1989) .... 80 FRF
Gas chromatographs for measuring pollution from pesticides and other toxic substances
Chromatographes en phase gazeuse pour la mesure des pollutions par pesticides et autres substances toxiques

R 83 (1990) .... 80 FRF
Gas chromatograph/mass spectrometer/data system for analysis of organic pollutants in water
Chromatographe en phase gazeuse équipé d'un spectromètre de masse et d'un système de traitement de données pour l'analyse des polluants organiques dans l'eau

R 99 (1998) .... 100 FRF
Instruments for measuring vehicle exhaust emissions
Instruments de mesure des gaz d'échappement des véhicules

R 100 (1991) .... 80 FRF
Atomic absorption spectrometers for measuring metal pollutants in water
Spectromètres d'absorption atomique pour la mesure des polluants métalliques dans l'eau

R 112 (1994) .... 80 FRF
High performance liquid chromatographs for measurement of pesticides and other toxic substances
Chromatographes en phase liquide de haute performance pour la mesure des pesticides et autres substances toxiques

R 113 (1994) .... 80 FRF
Portable gas chromatographs for field measurements of hazardous chemical pollutants
Chromatographes en phase gazeuse portatifs pour la mesure sur site des polluants chimiques dangereux

R 116 (1995) .... 80 FRF
Inductively coupled plasma atomic emission spectrometers for measurement of metal pollutants in water
Spectromètres à émission atomique de plasma couplé inductivement pour le mesurage des polluants métalliques dans l'eau

R 123 (1997) .... 100 FRF
Portable and transportable X-ray fluorescence spectrometers for field measurement of hazardous elemental pollutants
Spectromètres à fluorescence de rayons X portatifs et déplaçables pour la mesure sur le terrain d'éléments polluants dangereux

D 22 (1991) .... 80 FRF
Guide to portable instruments for assessing airborne pollutants arising from hazardous wastes
Guide sur les instruments portatifs pour l'évaluation des polluants contenus dans l'air en provenance des sites de décharge de déchets dangereux

Physico-chemical measurements
Mesures physico-chimiques

R 14 (1995) .... 60 FRF
Polarimetric saccharimeters
Saccharimètres polarimétriques

R 54 .... being revised - *en cours de révision*
pH scale for aqueous solutions
Échelle de pH des solutions aqueuses

R 56 (1981) .... 50 FRF
Standard solutions reproducing the conductivity of electrolytes
Solutions-étalons reproduisant la conductivité des électrolytes

R 59 (1984) .... 80 FRF
Moisture meters for cereal grains and oilseeds
Humidimètres pour grains de céréales et graines oléagineuses

R 68 (1985) .... 50 FRF
Calibration method for conductivity cells
Méthode d'étalonnage des cellules de conductivité

R 69 (1985) .... 50 FRF
Glass capillary viscometers for the measurement of kinematic viscosity. Verification method
Viscosimètres à capillaire, en verre, pour la mesure de la viscosité cinématique. Méthode de vérification

R 70 (1985) .... 50 FRF
Determination of intrinsic and hysteresis errors of gas analysers
Détermination des erreurs de base et d'hystérésis des analyseurs de gaz

R 73 (1985) .... 50 FRF
Requirements concerning pure gases CO, CO_2, CH_4, H_2, O_2, N_2 and Ar intended for the preparation of reference gas mixtures
Prescriptions pour les gaz purs CO, CO_2, CH_4, H_2, O_2, N_2 et Ar destinés à la préparation des mélanges de gaz de référence

R 92 (1989) .... 60 FRF
Wood-moisture meters - Verification methods and equipment: general provisions
Humidimètres pour le bois - Méthodes et moyens de vérification: exigences générales

R 108 (1993) .... 60 FRF
Refractometers for the measurement of the sugar content of fruit juices
Réfractomètres pour la mesure de la teneur en sucre des jus de fruits

R 121 (1996) .... 60 FRF
The scale of relative humidity of air certified against saturated salt solutions
Échelle d'humidité relative de l'air certifiée par rapport à des solutions saturées de sels

R 124 (1997) .... 80 FRF
Refractometers for the measurement of the sugar content of grape must
Réfractomètres pour la mesure de la teneur en sucre des moûts de raisin

R 126 (1998) .... 150 FRF
Evidential breath analyzers
Éthylomètres

D 17 (1987) .... 50 FRF
Hierarchy scheme for instruments measuring the viscosity of liquids
Schéma de hiérarchie des instruments de mesure de la viscosité des liquides

Medical instruments
Instruments médicaux

R 7 (1979-*1978*) .... 60 FRF
Clinical thermometers, mercury-in-glass with maximum device
Thermomètres médicaux à mercure, en verre, avec dispositif à maximum

R 16 (1973–*1970*) .... 50 FRF
Manometers for instruments for measuring blood pressure (sphygmomanometers)
Manomètres des instruments de mesure de la tension artérielle (sphygmomanomètres)

R 26 (1978–*1973*) .... 50 FRF
Medical syringes
Seringues médicales

R 78 (1989) .... 50 FRF
Westergren tubes for measurement of erythrocyte sedimentation rate
Pipettes Westergren pour la mesure de la vitesse de sédimentation des hématies

R 89 (1990) .... 80 FRF
Electroencephalographs - Metrological characteristics - Methods and equipment for verification
Électroencéphalographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 90 (1990) .... 80 FRF
Electrocardiographs - Metrological characteristics - Methods and equipment for verification
Électrocardiographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 93 .... being printed - *en cours d'impression*
Focimeters
Frontofocomètres

R 114 (1995) .... 80 FRF
Clinical electrical thermometers for continuous measurement
Thermomètres électriques médicaux pour mesurage en continu

R 115 (1995) .... 80 FRF
Clinical electrical thermometers with maximum device
Thermomètres électriques médicaux avec dispositif à maximum

R 122 (1996) .... 60 FRF
Equipment for speech audiometry
Appareils pour l'audiométrie vocale

R 128 .... being printed - *en cours d'impression*
Ergometers for foot crank work
Ergomètres à pédalier

D 21 (1990) .... 80 FRF
Secondary standard dosimetry laboratories for the calibration of dosimeters used in radiotherapy
Laboratoires secondaires d'étalonnage en dosimétrie pour l'étalonnage des dosimètres utilisés en radiothérapie

Testing of materials
Essais des matériaux

R 9 (1972–*1970*) .... 60 FRF
Verification and calibration of Brinell hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Brinell

R 10 (1974–*1970*) .... 60 FRF
Verification and calibration of Vickers hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Vickers

R 11 (1974–*1970*) .... 60 FRF
Verification and calibration of Rockwell B hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell B

R 12 (1974–*1970*) .... 60 FRF
Verification and calibration of Rockwell C hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell C

R 36 (1980–*1977*) .... 60 FRF
Verification of indenters for hardness testing machines
Vérification des pénétrateurs des machines d'essai de dureté

R 37 (1981–*1977*) .... 60 FRF
Verification of hardness testing machines (Brinell system)
Vérification des machines d'essai de dureté (système Brinell)

R 38 (1981–*1977*) .... 60 FRF
Verification of hardness testing machines (Vickers system)
Vérification des machines d'essai de dureté (système Vickers)

R 39 (1981–*1977*) .... 60 FRF
Verification of hardness testing machines (Rockwell systems B,F,T - C,A,N)
Vérification des machines d'essai de dureté (systèmes Rockwell B,F,T -C,A,N)

R 62 (1985) .... 80 FRF
Performance characteristics of metallic resistance strain gauges
Caractéristiques de performance des extensomètres métalliques à résistance

R 64 (1985) .... 50 FRF
General requirements for materials testing machines
Exigences générales pour les machines d'essai des matériaux

R 65 (1985) .... 60 FRF
Requirements for machines for tension and compression testing of materials
Exigences pour les machines d'essai des matériaux en traction et en compression

V 3 (1991) .... 80 FRF
Hardness testing dictionary (quadrilingual French-English-German-Russian)
Dictionnaire des essais de dureté (quadrilingue français-anglais-allemand-russe)

P 10 (1981) .... 50 FRF
The metrology of hardness scales - Bibliography

P 11 (1983) .... 100 FRF
Factors influencing hardness measurement

P 12 (1984) .... 100 FRF
Hardness test blocks and indenters

P 13 (1989) .... 100 FRF
Hardness standard equipment

P 14 (1991) .... 100 FRF
The unification of hardness measurement

Prepackaging
Préemballages

R 79 (1997) .... 60 FRF
Labeling requirements for prepackaged products
Exigences pour l'étiquetage des produits préemballés

R 87 (1989) .... 50 FRF
Net content in packages
Contenu net des préemballages

Ionizing radiations
Rayonnements ionisants

R 127 .... being printed - *en cours d'impression*
Radiochromic film dosimetry system for ionizing radiation processing of materials and products
Systèmes de dosimétrie par film radiochromique pour le traitement par rayonnement ionisant de matériaux et de produits

OIML Publications (By Number)

INTERNATIONAL RECOMMENDATIONS
RECOMMANDATIONS INTERNATIONALES

R 4 (1970-1972) .... 50 FRF
Volumetric flasks (one mark) in glass
Fioles jaugées à un trait en verre

R 6 (1989) .... 80 FRF
General provisions for gas volume meters
Dispositions générales pour les compteurs de volume de gaz

R 7 (1979-1978) .... 60 FRF
Clinical thermometers, mercury-in-glass with maximum device
Thermomètres médicaux à mercure, en verre, avec dispositif à maximum

R 9 (1972-1970) .... 60 FRF
Verification and calibration of Brinell hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Brinell

R 10 (1974-1970) .... 60 FRF
Verification and calibration of Vickers hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Vickers

R 11 (1974-1970) .... 60 FRF
Verification and calibration of Rockwell B hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell B

R 12 (1974-1970) .... 60 FRF
Verification and calibration of Rockwell C hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell C

R 14 (1995) .... 60 FRF
Polarimetric saccharimeters
Saccharimètres polarimétriques

R 15 (1974–1970) .... 80 FRF
Instruments for measuring the hectolitre mass of cereals
Instruments de mesure de la masse à l'hectolitre des céréales

R 16 (1973–1970) .... 50 FRF
Manometers for instruments for measuring blood pressure (sphygmomanometers)
Manomètres des instruments de mesure de la tension artérielle (sphygmomanomètres)

R 18 (1989) .... 60 FRF
Visual disappearing filament pyrometers
Pyromètres optiques à filament disparaissant

R 21 (1975–1973) .... 60 FRF
Taximeters
Taximètres

R 22 (1975–1973) .... 150 FRF
International alcoholometric tables (trilingual French-English-Spanish)
Tables alcoométriques internationales (trilingue français-anglais-espagnol)

R 23 (1975–1973) .... 60 FRF
Tyre pressure gauges for motor vehicles
Manomètres pour pneumatiques de véhicules automobiles

R 24 (1975–1973) .... 50 FRF
Standard one metre bar for verification officers
Mètre étalon rigide pour agents de vérification

R 26 (1978–1973) .... 50 FRF
Medical syringes
Seringues médicales

R 29 (1979–1973) .... 50 FRF
Capacity serving measures
Mesures de capacité de service

R 30 (1981) .... 60 FRF
End standards of length (gauge blocks)
Mesures de longueur à bouts plans (cales étalons)

R 31 (1995) .... 80 FRF
Diaphragm gas meters
Compteurs de gaz à parois déformables

R 32 (1989) .... 60 FRF
Rotary piston gas meters and turbine gas meters
Compteurs de volume de gaz à pistons rotatifs et compteurs de volume de gaz à turbine

R 33 (1979–1973) .... 50 FRF
Conventional value of the result of weighing in air
Valeur conventionnelle du résultat des pesées dans l'air

R 34 (1979–1974) .... 60 FRF
Accuracy classes of measuring instruments
Classes de précision des instruments de mesurage

R 35 (1985) .... 80 FRF
Material measures of length for general use
Mesures matérialisées de longueur pour usages généraux

R 36 (1980–1977) .... 60 FRF
Verification of indenters for hardness testing machines
Vérification des pénétrateurs des machines d'essai de dureté

R 37 (1981–1977) .... 60 FRF
Verification of hardness testing machines (Brinell system)
Vérification des machines d'essai de dureté (système Brinell)

R 38 (1981–1977) .... 60 FRF
Verification of hardness testing machines (Vickers system)
Vérification des machines d'essai de dureté (système Vickers)

R 39 (1981–1977) .... 60 FRF
Verification of hardness testing machines (Rockwell systems B,F,T-C,A,N)
Vérification des machines d'essai de dureté (systèmes Rockwell B,F,T-C,A,N)

R 40 (1981–1977) .... 60 FRF
Standard graduated pipettes for verification officers
Pipettes graduées étalons pour agents de vérification

R 41 (1981–1977) .... 60 FRF
Standard burettes for verification officers
Burettes étalons pour agents de vérification

R 42 (1981–1977) .... 50 FRF
Metal stamps for verification officers
Poinçons de métal pour agents de vérification

R 43 (1981–1977) .... 60 FRF
Standard graduated glass flasks for verification officers
Fioles étalons graduées en verre pour agents de vérification

R 44 (1985) .... 50 FRF
Alcoholometers and alcohol hydrometers and thermometers for use in alcoholometry
Alcoomètres et aréomètres pour alcool et thermomètres utilisés en alcoométrie

R 45 (1980–1977) .... 50 FRF
Casks and barrels
Tonneaux et futailles

R 46 .... being revised - *en cours de révision*
Active electrical energy meters for direct connection of class 2
Compteurs d'énergie électrique active à branchement direct de la classe 2

R 47 (1979–1978) .... 60 FRF
Standard weights for testing of high capacity weighing machines
Poids étalons pour le contrôle des instruments de pesage de portée élevée

R 48 (1980–1978) .... 50 FRF
Tungsten ribbon lamps for calibration of optical pyrometers
Lampes à ruban de tungstène pour l'étalonnage des pyromètres optiques

R 49 .... being revised - *en cours de révision*
Water meters intended for the metering of cold water
Compteurs d'eau destinés au mesurage de l'eau froide

R 50-1 (1997) .... 150 FRF
Continuous totalizing automatic weighing instruments (Belt weighers). Part 1: Metrological and technical requirements - Tests
Instruments de pesage totalisateurs continus à fonction nement automatique (peseuses sur bande). Partie 1: Exigences métrologiques et techniques - Essais

R 50-2 (1997) .... 200 FRF
Continuous totalizing automatic weighing instruments (Belt weighers). Part 2: Test report format
Instruments de pesage totalisateurs continus à fonctionnement automatique (peseuses sur bande). Partie 2: Format du rapport d'essai

R 51-1 (1996) .... 100 FRF
Automatic catchweighing instruments. Part 1: Metrological and technical requirements - Tests
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique. Partie 1: Exigences métrologiques et techniques - Essais

R 51-2 (1996) .... 300 FRF
Automatic catchweighing instruments. Part 2: Test report format
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique. Partie 2: Format du rapport d'essai

R 52 (1980) .... 50 FRF
Hexagonal weights, ordinary accuracy class from 100 g to 50 kg
Poids hexagonaux de classe de précision ordinaire, de 100 g à 50 kg

R 53 (1982) .... 60 FRF
Metrological characteristics of elastic sensing elements used for measurement of pressure. Determination methods
Caractéristiques métrologiques des éléments récepteurs élastiques utilisés pour le mesurage de la pression. Méthodes de leur détermination

R 54 .... being revised - *en cours de révision*
pH scale for aqueous solutions
Échelle de pH des solutions aqueuses

R 55 (1981) .... 50 FRF
Speedometers, mechanical odometers and chronotachographs for motor vehicles. Metrological regulations
Compteurs de vitesse, compteurs mécaniques de distance et chronotachygraphes des véhicules automobiles. Réglementation métrologique

R 56 (1981) .... 50 FRF
Standard solutions reproducing the conductivity of electrolytes
Solutions-étalons reproduisant la conductivité des électrolytes

R 58 (1998) .... 80 FRF
Sound level meters
Sonomètres

R 59 (1984) .... 80 FRF
Moisture meters for cereal grains and oilseeds
Humidimètres pour grains de céréales et graines oléagineuses

R 60 (1991) .... 80 FRF
Metrological regulation for load cells
Réglementation métrologique des cellules de pesée
Annex (1993) .... 80 FRF
Test report format for the evaluation of load cells
Format du rapport d'essai des cellules de pesée

R 61-1 (1996) .... 150 FRF
Automatic gravimetric filling instruments. Part 1: Metrological and test requirements - Tests
Doseuses pondérales à fonctionnement automatique. Partie 1: Exigences métrologiques et techniques - Essais

R 61-2 (1996) .... 250 FRF
Automatic gravimetric filling instruments. Part 2: Test report format
Doseuses pondérales à fonctionnement automatique. Partie 2: Format du rapport d'essai

R 62 (1985) .... 80 FRF
Performance characteristics of metallic resistance strain gauges
Caractéristiques de performance des extensomètres métalliques à résistance

R 63 (1994) .... 50 FRF
Petroleum measurement tables
Tables de mesure du pétrole

R 64 (1985) .... 50 FRF
General requirements for materials testing machines
Exigences générales pour les machines d'essai des matériaux

R 65 (1985) .... 60 FRF
Requirements for machines for tension and compression testing of materials
Exigences pour les machines d'essai des matériaux en traction et en compression

R 66 (1985) .... 60 FRF
Length measuring instruments
Instruments mesureurs de longueurs

R 68 (1985) .... 50 FRF
Calibration method for conductivity cells
Méthode d'étalonnage des cellules de conductivité

R 69 (1985) .... 50 FRF
Glass capillary viscometers for the measurement of kinematic viscosity. Verification method
Viscosimètres à capillaire, en verre, pour la mesure de la viscosité cinématique. Méthode de vérification

R 70 (1985) .... 50 FRF
Determination of intrinsic and hysteresis errors of gas analysers
Détermination des erreurs de base et d'hystérésis des analyseurs de gaz

R 71 (1985) .... 80 FRF
Fixed storage tanks. General requirements
Réservoirs de stockage fixes. Prescriptions générales

R 72 (1985) .... 60 FRF
Hot water meters
Compteurs d'eau destinés au mesurage de l'eau chaude

R 73 (1985) .... 50 FRF
Requirements concerning pure gases CO, CO_2, CH_4, H_2, O_2, N_2 and Ar intended for the preparation of reference gas mixtures
Prescriptions pour les gaz purs CO, CO_2, CH_4, H_2, O_2, N_2 et Ar destinés à la préparation des mélanges de gaz de référence

R 74 (1993) .... 80 FRF
Electronic weighing instruments
Instruments de pesage électroniques

R 75 (1988) .... 60 FRF
Heat meters
Compteurs d'énergie thermique

R 76-1 (1992) .... 300 FRF
Nonautomatic weighing instruments. Part 1: Metrological and technical requirements - Tests
Instruments de pesage à fonctionnement non automatique. Partie 1: Exigences métrologiques et techniques - Essais
Amendment No. 1 (1994) .... NC

R 76-2 (1993) .... 200 FRF
Nonautomatic weighing instruments.
Part 2: Pattern evaluation report
Instruments de pesage à fonctionnement non automatique. Partie 2: Rapport d'essai de modèle
Amendment No. 1 (1995) .... NC

R 78 (1989) .... 50 FRF
Westergren tubes for measurement of erythrocyte sedimentation rate
Pipettes Westergren pour la mesure de la vitesse de sédimentation des hématies

R 79 (1997) .... 60 FRF
Labeling requirements for prepackaged products
Exigences pour l'étiquetage des produits préemballés

R 80 (1989) .... 100 FRF
Road and rail tankers
Camions et wagons-citernes

R 81 (1998) .... 150 FRF
Dynamic measuring devices and systems for cryogenic liquids (including tables of density for liquid argon, helium, hydrogen, nitrogen and oxygen)
Dispositifs et systèmes de mesure dynamique de liquides cryogéniques (comprend tables de masse volumique pour argon, hélium, hydrogène, azote et oxygène liquides)

R 82 (1989) .... 80 FRF
Gas chromatographs for measuring pollution from pesticides and other toxic substances
Chromatographes en phase gazeuse pour la mesure des pollutions par pesticides et autres substances toxiques

R 83 (1990) .... 80 FRF
Gas chromatograph/mass spectrometer/data system for analysis of organic pollutants in water
Chromatographe en phase gazeuse équipé d'un spectromètre de masse et d'un système de traitement de données pour l'analyse des polluants organiques dans l'eau

R 84 (1989) .... 60 FRF
Resistance-thermometer sensors made of platinum, copper or nickel (for industrial and commercial use)
Capteurs à résistance thermométrique de platine, de cuivre ou de nickel (à usages techniques et commerciaux)

R 85 (1998) .... 150 FRF
Automatic level gauges for measuring the level of liquid in fixed storage tanks
Jaugeurs automatiques pour le mesurage des niveaux de liquide dans les réservoirs de stockage fixes

R 86 (1989) .... 50 FRF
Drum meters for alcohol and their supplementary devices
Compteurs à tambour pour alcool et leurs dispositifs complémentaires

R 87 (1989) .... 50 FRF
Net content in packages
Contenu net des préemballages

R 88 (1998) .... 80 FRF
Integrating-averaging sound level meters
Sonomètres intégrateurs-moyenneurs

R 89 (1990) .... 80 FRF
Electroencephalographs - Metrological characteristics - Methods and equipment for verification
Électroencéphalographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 90 (1990) .... 80 FRF
Electrocardiographs - Metrological characteristics - Methods and equipment for verification
Électrocardiographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 91 (1990) .... 60 FRF
Radar equipment for the measurement of the speed of vehicles
Cinémomètres radar pour la mesure de la vitesse des véhicules

R 92 (1989) .... 60 FRF
Wood-moisture meters - Verification methods and equipment: general provisions
Humidimètres pour le bois - Méthodes et moyens de vérification: exigences générales

R 93 .... being printed - *en cours d'impression*
Focimeters
Frontofocomètres

R 95 (1990) .... 60 FRF
Ships' tanks - General requirements
Bateaux-citernes - Prescriptions générales

R 96 (1990) .... 50 FRF
Measuring container bottles
Bouteilles récipients-mesures

R 97 (1990) .... 60 FRF
Barometers
Baromètres

R 98 (1991) .... 60 FRF
High-precision line measures of length
Mesures matérialisées de longueur à traits de haute précision

R 99 (1998) .... 100 FRF
Instruments for measuring vehicle exhaust emissions
Instruments de mesure des gaz d'échappement des véhicules

R 100 (1991) .... 80 FRF
Atomic absorption spectrometers for measuring metal pollutants in water
Spectromètres d'absorption atomique pour la mesure des polluants métalliques dans l'eau

R 101 .... being printed - *en cours d'impression*
Indicating and recording pressure gauges, vacuum gauges and pressure vacuum gauges with elastic sensing elements (ordinary instruments)
Manomètres, vacuomètres et manovacuomètres indicateurs et enregistreurs à élément récepteur élastique (instruments usuels)

R 102 (1992) .... 50 FRF
Sound calibrators
Calibreurs acoustiques

Annex (1995) .... 80 FRF
Test methods for pattern evaluation and test report format
Méthodes d'essai de modèle et format du rapport d'essai

R 103 (1992) .... 60 FRF
Measuring instrumentation for human response to vibration
Appareillage de mesure pour la réponse des individus aux vibrations

R 104 (1993) .... 60 FRF
Pure-tone audiometers
Audiomètres à sons purs

Annex F (1997) .... 100 FRF
Test report format
Format du rapport d'essai

R 105 (1993) .... 100 FRF
Direct mass flow measuring systems for quantities of liquids
Ensembles de mesurage massiques directs de quantités de liquides

Annex (1995) .... 80 FRF
Test report format
Format du rapport d'essai

R 106-1 (1997) .... 150 FRF
Automatic rail-weighbridges. Part 1: Metrological and technical requirements - Tests
Ponts-bascules ferroviaires à fonctionnement automatique. Partie 1: Exigences métrologiques et techniques - Essais

R 106-2 (1997) .... 250 FRF
Automatic rail-weighbridges. Part 2: Test report format
Ponts-bascules ferroviaires à fonctionnement automatique. Partie 2: Format du rapport d'essai

R 107-1 (1997) .... 150 FRF
Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers). Part 1: Metrological and technical requirements - Tests
Instruments de pesage totalisateurs discontinus à fonctionnement automatique (peseuses totalisatrices à trémie). Partie 1: Exigences métrologiques et techniques - Essais

R 107-2 (1997) .... 300 FRF
Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers). Part 2: Test report format
Instruments de pesage totalisateurs discontinus à fonctionnement automatique (peseuses totalisatrices à trémie). Partie 2: Format du rapport d'essai

R 108 (1993) .... 60 FRF
Refractometers for the measurement of the sugar content of fruit juices
Réfractomètres pour la mesure de la teneur en sucre des jus de fruits

R 109 .... being printed - *en cours d'impression*
Pressure gauges and vacuum gauges with elastic sensing elements (standard instruments)
Manomètres et vacuomètres à élément récepteur élastique (instruments étalons)

R 110 (1994) .... 80 FRF
Pressure balances
Manomètres à piston

R 111 (1994) .... 80 FRF
Weights of classes E_1, E_2, F_1, F_2, M_1, M_2, M_3
Poids des classes E_1, E_2, F_1, F_2, M_1, M_2, M_3

R 112 (1994) .... 80 FRF
High performance liquid chromatographs for measurement of pesticides and other toxic substances
Chromatographes en phase liquide de haute performance pour la mesure des pesticides et autres substances toxiques

R 113 (1994) .... 80 FRF
Portable gas chromatographs for field measurements of hazardous chemical pollutants
Chromatographes en phase gazeuse portatifs pour la mesure sur site des polluants chimiques dangereux

R 114 (1995) .... 80 FRF
Clinical electrical thermometers for continuous measurement
Thermomètres électriques médicaux pour mesurage en continu

R 115 (1995) .... 80 FRF
Clinical electrical thermometers with maximum device
Thermomètres électriques médicaux avec dispositif à maximum

R 116 (1995) .... 80 FRF
Inductively coupled plasma atomic emission spectrometers for measurement of metal pollutants in water
Spectromètres à émission atomique de plasma couplé inductivement pour le mesurage des polluants métalliques dans l'eau

R 117 (1995) .... 400 FRF
Measuring systems for liquids other than water
Ensembles de mesurage de liquides autres que l'eau

R 118 (1995) .... 100 FRF
Testing procedures and test report format for pattern evaluation of fuel dispensers for motor vehicles
Procédures d'essai et format du rapport d'essai des modèles de distributeurs de carburant pour véhicules à moteur

R 119 (1996) .... 80 FRF
Pipe provers for testing measuring systems for liquids other than water
Tubes étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

R 120 (1996) .... 100 FRF
Standard capacity measures for testing measuring systems for liquids other than water
Mesures de capacité étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

R 121 (1996) .... 60 FRF
The scale of relative humidity of air certified against saturated salt solutions
Échelle d'humidité relative de l'air certifiée par rapport à des solutions saturées de sels

R 122 (1996) .... 60 FRF
Equipment for speech audiometry
Appareils pour l'audiométrie vocale

R 123 (1997) .... 100 FRF
Portable and transportable X-ray fluorescence spectrometers for field measurement of hazardous elemental pollutants
Spectromètres à fluorescence de rayons X portatifs et déplaçables pour la mesure sur le terrain d'éléments polluants dangereux

R 124 (1997) .... 80 FRF
Refractometers for the measurement of the sugar content of grape must
Réfractomètres pour la mesure de la teneur en sucre des moûts de raisin

R 125 (1998) .... 100 FRF
Measuring systems for the mass of liquids in tanks
Systèmes de mesure de la masse des liquides dans les réservoirs

R 126 (1998) .... 150 FRF
Evidential breath analyzers
Éthylomètres

R 127 .... being printed - *en cours d'impression*
Radiochromic film dosimetry system for ionizing radiation processing of materials and products
Systèmes de dosimétrie par film radiochromique pour le traitement par rayonnement ionisant de matériaux et de produits

R 128 .... being printed - *en cours d'impression*
Ergometers for foot crank work
Ergomètres à pédalier

International Documents
Documents Internationaux

D 1 (1975) .... 50 FRF
Law on metrology
Loi de métrologie

D 2 (1998) .... 80 FRF
Legal units of measurement
Unités de mesure légales

D 3 (1979) .... 60 FRF
Legal qualification of measuring instruments
Qualification légale des instruments de mesurage

D 4 (1981) .... 50 FRF
Installation and storage conditions for cold water meters
Conditions d'installation et de stockage des compteurs d'eau froide

D 5 (1982) .... 60 FRF
Principles for the establishment of hierarchy schemes for measuring instruments
Principes pour l'établissement des schémas de hiérarchie des instruments de mesure

D 6 (1983) .... 60 FRF
Documentation for measurement standards and calibration devices
Documentation pour les étalons et les dispositifs d'étalonnage

D 7 (1984) .... 80 FRF
The evaluation of flow standards and facilities used for testing water meters
Évaluation des étalons de débitmétrie et des dispositifs utilisés pour l'essai des compteurs d'eau

D 8 (1984) .... 60 FRF
Principles concerning choice, official recognition, use and conservation of measurement standards
Principes concernant le choix, la reconnaissance officielle, l'utilisation et la conservation des étalons

D 9 (1984) .... 60 FRF
Principles of metrological supervision
Principes de la surveillance métrologique

D 10 (1984) .... 50 FRF
Guidelines for the determination of recalibration intervals of measuring equipment used in testing laboratories
Conseils pour la détermination des intervalles de réétalonnage des équipements de mesure utilisés dans les laboratoires d'essais

D 11 (1994) .... 80 FRF
General requirements for electronic measuring instruments
Exigences générales pour les instruments de mesure électroniques

D 12 (1986) .... 50 FRF
Fields of use of measuring instruments subject to verification
Domaines d'utilisation des instruments de mesure assujettis à la vérification

D 13 (1986) .... 50 FRF
Guidelines for bi- or multilateral arrangements on the recognition of: test results - pattern approvals - verifications
Conseils pour les arrangements bi- ou multilatéraux de reconnaissance des: résultats d'essais - approbations de modèles - vérifications

D 14 (1989) .... 60 FRF
Training of legal metrology personnel - Qualification - Training programs
Formation du personnel en métrologie légale - Qualification - Programmes d'étude

D 15 (1986) .... 80 FRF
Principles of selection of characteristics for the examination of measuring instruments
Principes du choix des caractéristiques pour l'examen des instruments de mesure usuels

D 16 (1986) .... 80 FRF
Principles of assurance of metrological control
Principes d'assurance du contrôle métrologique

D 17 (1987) .... 50 FRF
Hierarchy scheme for instruments measuring the viscosity of liquids
Schéma de hiérarchie des instruments de mesure de la viscosité des liquides

D 18 (1987) .... 50 FRF
General principles of the use of certified reference materials in measurements
Principes généraux d'utilisation des matériaux de référence certifiés dans les mesurages

D 19 (1988) .... 80 FRF
Pattern evaluation and pattern approval
Essai de modèle et approbation de modèle

D 20 (1988) .... 80 FRF
Initial and subsequent verification of measuring instruments and processes
Vérifications primitive et ultérieure des instruments et processus de mesure

D 21 (1990) .... 80 FRF
Secondary standard dosimetry laboratories for the calibration of dosimeters used in radiotherapy
Laboratoires secondaires d'étalonnage en dosimétrie pour l'étalonnage des dosimètres utilisés en radiothérapie

D 22 (1991) .... 80 FRF
Guide to portable instruments for assessing airborne pollutants arising from hazardous wastes
Guide sur les instruments portatifs pour l'évaluation des polluants contenus dans l'air en provenance des sites de décharge de déchets dangereux

D 23 (1993) .... 80 FRF
Principles of metrological control of equipment used for verification
Principes du contrôle métrologique des équipements utilisés pour la vérification

D 24 (1996) .... 60 FRF
Total radiation pyrometers
Pyromètres à radiation totale

D 25 (1996) .... 60 FRF
Vortex meters used in measuring systems for fluids
Compteurs à vortex utilisés dans les ensembles de mesurage de fluides

D 26 .... being printed - *en cours de publication*
Glass delivery measures - Automatic pipettes
Mesures en verre à délivrer - Pipettes automatiques

VOCABULARIES
VOCABULAIRES

V 1 (1978) .... 100 FRF
Vocabulary of legal metrology (bilingual French-English)
Vocabulaire de métrologie légale (bilingue français-anglais)

V 2 (1993) .... 200 FRF
International vocabulary of basic and general terms in metrology (bilingual French-English)
Vocabulaire international des termes fondamentaux et généraux de métrologie (bilingue français-anglais)

V 3 (1991) .... 80 FRF
Hardness testing dictionary (quadrilingual French-English-German-Russian)
Dictionnaire des essais de dureté (quadrilingue français-anglais-allemand-russe)

OTHER PUBLICATIONS
AUTRES PUBLICATIONS

P 1 (1991) .... 60 FRF
OIML Certificate System for Measuring Instruments
Système de Certificats OIML pour les Instruments de Mesure

P 2 (1987) .... 100 FRF
Metrology training - Synthesis and bibliography (bilingual French-English)
Formation en métrologie - Synthèse et bibliographie (bilingue français-anglais)

P 3-1 (1996) .... 400 FRF
Legal metrology in OIML Member States
Métrologie légale dans les États Membres de l'OIML

P 3-2 (1996) .... 300 FRF
Legal metrology in OIML Corresponding Members
Métrologie légale dans les Membres Correspondants de l'OIML

P 4 (1986–*1981*) .... 100 FRF
Verification equipment for National Metrology Services
Équipement d'un Service national de métrologie

P 5 (1992) .... 100 FRF
Mobile equipment for the verification of road weighbridges (bilingual French- English)
Équipement mobile pour la vérification des ponts-bascules routiers (bilingue français-anglais)

P 6 (1987) .... 100 FRF
Suppliers of verification equipment (bilingual French-English)
Fournisseurs d'équipement de vérification (bilingue français-anglais)

P 7 (1989) .... 100 FRF
Planning of metrology and testing laboratories
Planification de laboratoires de métrologie et d'essais

P 8 (1987) .... 100 FRF
Density measurement
Mesure de la masse volumique

P 9 (1992) .... 100 FRF
Guidelines for the establishment of simplified metrology regulations

P 10 (1981) .... 50 FRF
The metrology of hardness scales - Bibliography

P 11 (1983) .... 100 FRF
Factors influencing hardness measurement

P 12 (1984) .... 100 FRF
Hardness test blocks and indenters

P 13 (1989) .... 100 FRF
Hardness standard equipment

P 14 (1991) .... 100 FRF
The unification of hardness measurement

P 15 (1989) .... 100 FRF
Guide to calibration

P 16 (1991) .... 100 FRF
Guide to practical temperature measurements

P 17 (1995) .... 300 FRF
Guide to the expression of uncertainty in measurement
Guide pour l'expression de l'incertitude de mesure

OIML BULLETIN

▸ CALL FOR PAPERS ◂

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

Authors are requested to submit:

- a titled, typed manuscript;
- the originals of any relevant visual materials (photos, illustrations, diagrams, etc.);
- a disk copy in either WordPerfect or Word (PC or Apple Macintosh);
- a passport-size, black and white identity photo suitable for publication;
- full contact details including name, position, institution, address, telephone, fax and e-mail.

Papers selected for publication will be remunerated at the rate of 150 FRF per printed page, provided that they have not already been published in other journals. The Editors reserve the right to edit contributions for style, space and linguistic reasons. Author approval is always obtained prior to publication and the Editors decline any liability for claims made in articles, which are the sole responsibility of the authors concerned.

Please send submissions to:

Bernard Athané, Editor-in-Chief — Chris Pulham, Editor
OIML Bulletin
Bureau International de Métrologie Légale (BIML)
11, rue Turgot - F-75009 Paris - France

Telephone: +33 (0)1 48 78 12 82 or +33 (0)1 42 85 27 11
Fax: +33 (0)1 42 82 17 27
E-mail: biml@oiml.org