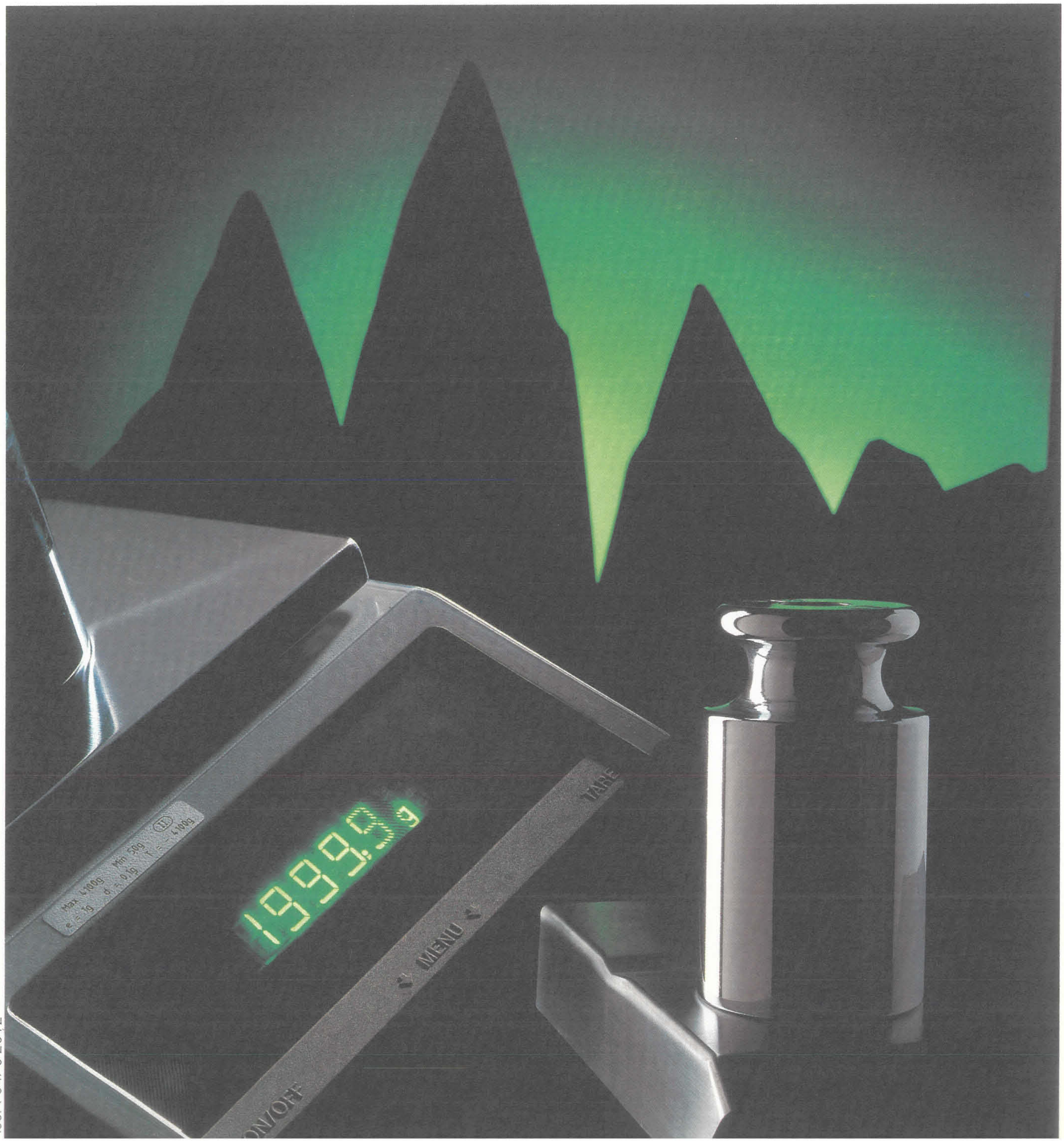
OIML BULLETIN

VOLUME XXXV NUMBER 2 APRIL 1994

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

QUARTERLY JOURNAL



ISSN 0473-2812

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VOLUME XXXV NUMBER 2
APRIL 1994

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.

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1994 SUBSCRIPTION RATES
EUROPE: 400 FRF
OUTSIDE EUROPE: 450 FRF

ISSN 0473-2812
DEPOT LEGAL NO 8840
PRINTED IN FRANCE
GRANDE IMPRIMERIE DE TROYES
130, RUE GÉNÉRAL DE GAULLE
10000 TROYES

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OIML BULLETIN

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technique

evolutions

update

Variations in gravity can influence significantly the results of certain weighing instruments. A focus on some efforts that have been made to address this issue.

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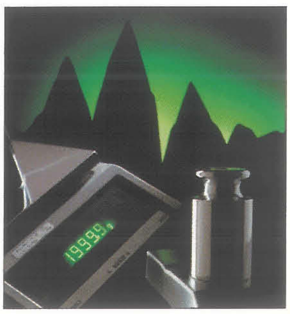

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OIML BULLETIN

VOLUME XXXV NUMÉRO 2 AVRIL 1994

technique

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d'un bulletin à l'autre

Editorial

We are heading towards a society whose continual demand is to be "better informed" and "quickly informed". When one stops to consider the degree to which seemingly unrelated disciplines have become interdependent, the "information challenge" of this era reveals itself with considerable amplitude. Legal metrology constitutes one of the elements of the complex network connecting science, industry, trade, media, politics, consumers, and services and this is why we recognize the importance of responding to the different information needs of the metrology community.

Collaboration: Editors at work on the Bulletin.

It is in this context that we are striving to develop the OIML Bulletin though a new structure and presentation. Readers interested in the technical aspects of metrology will find a selection of articles suited to this purpose in the rubric **Technique. Evolutions** is a new section intended to reflect international, national, and regional trends in metrology and related fields, and to focus on certain OIML activities and structures to give our readers more insight into the Organisation's developments. With the rubric **Update,** we are addressing readers seeking to be kept up-to-date on meetings, conferences, and general progress made in OIML and other liaison institutions.

Within this framework, our approach can be resumed in two words: diversity and quality. The expansion of legal metrology leads to *diverse* subjects such as accreditation, certification, privatization of traditionally governmental structures, and the importance of measurement credibility at the consumer level. Moreover, we intend to present these new subjects with a particular attention to the *quality* of texts and illustrations.

We welcome our new readers and thank those who continue to take interest in the evolution of the OIML Bulletin. Our goal is to meet the challenge that accompanies the growing complexity of interrelations between legal metrology and other areas. We hope that our efforts will result in creating the necessary synergies.

K. French, Editor

La société de demain demandera sans cesse à être informée mieux et plus vite. Si l'on s'arrête un instant pour considérer à quel point des disciplines, apparemment sans rapport entre elles, sont devenues interdépendantes, le défi informatif de cette ère se révèle d'une importance capitale. La métrologie légale constitue un maillon du réseau complexe reliant sciences, industrie, commerce, médias, politique, consommateurs et services. C'est pourquoi nous sommes conscients de la nécessité de répondre aux différents besoins d'information de la communauté métrologique.

C'est dans ce contexte que nous nous sommes efforcés de développer le Bulletin OIML par une nouvelle structure et une nouvelle présentation. Les lecteurs intéressés par les aspects techniques de la métrologie trouveront un choix d'articles dans la rubrique **Technique. Evolutions** est une nouvelle section reflétant les tendances internationales, régionales et nationales, de la métrologie et des secteurs en liaison et traitant de certaines activités et structures de l'OIML afin de donner aux lecteurs un aperçu des développements de l'Organisation. Enfin, dans la rubrique **D'un bulletin à l'autre,** nous informons nos lecteurs des mises à jour concernant réunions, conférences, progrès dans les travaux de l'OIML et autres institutions en liaison.

Dans ce cadre, notre approche peut se résumer en deux mots: diversité et qualité. L'expansion de la métrologie légale mène à différents sujets tels que l'accréditation, la certification, la privatisation de certains secteurs traditionnellement publics et l'importance de la crédibilité des mesures au niveau du consommateur. Bien plus, nous voulons présenter ces nouveaux sujets en soignant la qualité des textes et des illustrations.

Bienvenue à nos nouveaux lecteurs et merci à ceux qui continuent à s'intéresser à l'évolution du Bulletin de l'OIML. Notre objectif: relever le défi né de la complexité grandissante des relations entre la métrologie légale et les autres domaines. Nous espérons créer par ces efforts les synergies indispensables.

Ph. Degavre, Editor

Satisfy ISO-9000

A NEW APPROACH TO VERIFYING NONAUTOMATIC WEIGHING INSTRUMENTS

H. KÄLLGREN AND P. LAU
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This article contributes to the debate on the OIML International Recommendation R 76 for the testing of nonautomatic weighing instruments. The authors discuss the requirements of this Recommendation with respect to the verification uncertainty, which is found to be insufficient. In contrast to the requirement of a limited error of the standard weights used, a limited total measurement uncertainty is suggested. With this approach, the verification of a weighing instrument may be used for judging the in-service or industrial production uncertainty. The authors also suggest that a regular verification combined with ordinary calibration aspects be accepted as the most appropriate method for satisfying the quality assurance requirements in ISO-9000.

Verification accuracy

The verification of a weighing instrument shall state that it conforms to certain internationally agreed criteria. The main question is whether the instrument produces values that lie within a well-defined range during a standardized test procedure. From these test procedures, a high degree of confidence must be obtained in that which concerns the test results.

The test procedure consists of gradually increasing the load to the instrument maximum capacity and then decreasing the load to zero. The maximum permissible error (MPE) is based on the verification scale interval *e* and is a function of the applied load as shown in Fig. 1 (valid for a class III instrument).

The correctness of the instrument is defined through the value of the applied load, i.e. the mass of the weights used. This means that a certain accuracy is required for the standard weights used. The weighing instrument also contributes to the testing uncertainty and must therefore fulfil certain requirements with regard to its repeatability.

What does the OIML International Recommendation R 76 [1] state concerning the measurement uncertainty in the verification of nonautomatic weighing instruments? Three important requirements are the following (cited from OIML R 76):

§ 3.6 Permissible differences between results

Regardless of what variation of results is permitted, the error of any single weighing result shall by itself not exceed the maximum permissible error for the given load.

§ 3.6.1 Repeatability

The difference between the results of several weighings of the same load shall not be greater than the absolute value of the maximum permissible error of the instrument for that load.

§ 3.7.1 Weights

The standard weights or standard masses used for the verification of an instrument shall not have an error greater than 1/3 of the maximum permissible error of the instrument for the applied load.

These three demands are simple and seem clear enough. But are they sufficient for correctly judging whether a weighing instrument has passed the verification test or not (generally with a 95 % level of confidence)?

Before answering this question it is necessary to comment on the factor 1/3 in 3.7.1. Given two independent sources of error (normal distribution and quadratic summation assumed) that together make up the total error and given further that the error in one

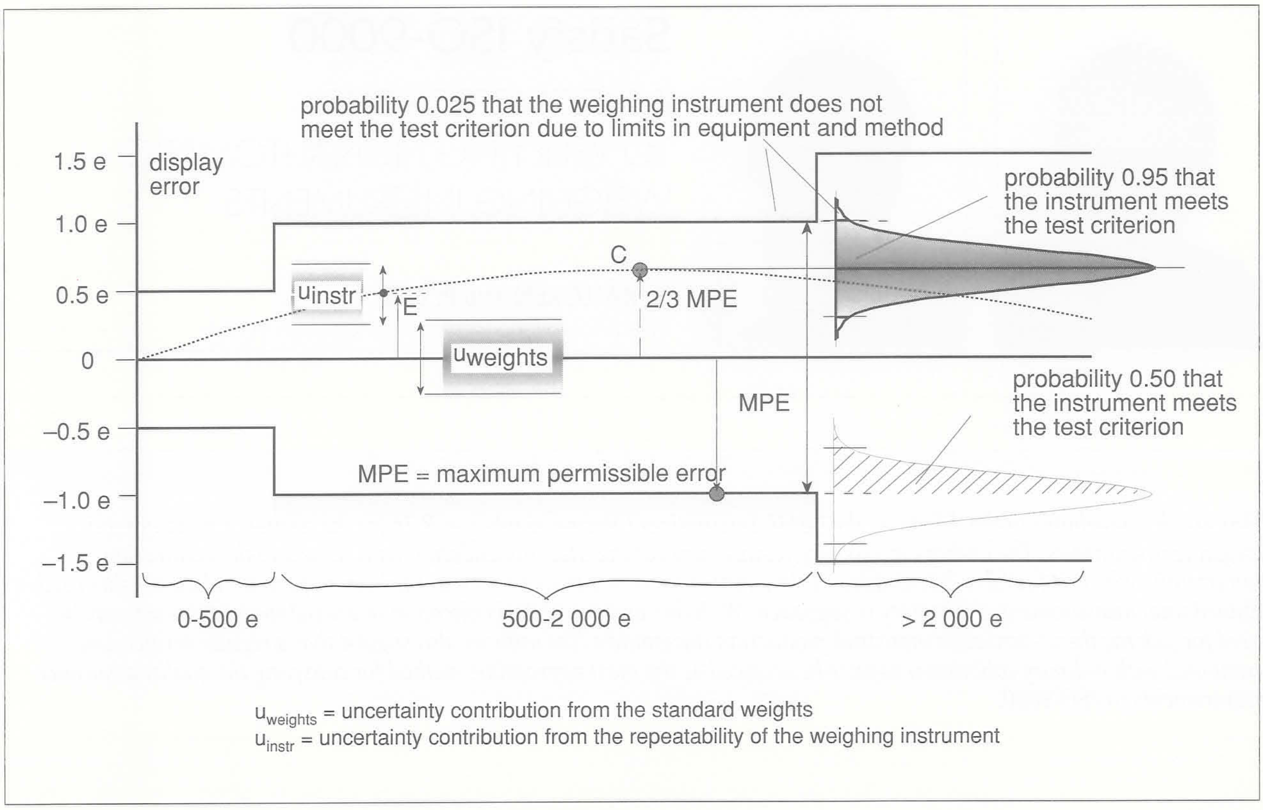

Fig. 1 The characteristic C of a class III weighing instrument under a verification test.

source (the weights) amounts to 1/3 of this total error (MPE), it follows from

$$\sqrt{(x\ MPE)^2 + (1/3\ \ MPE)^2} = MPE$$

and

$$x = \sqrt{1^2 - (1/3)^2} \approx 0.95$$

that the source x contributes to the total error by 95 % whereas the first source contributes by at most 5 % (this can be considered to be a reasonable amount).

Therefore, if we want to verify an instrument, we should perform this test with an uncertainty in the measured and reported values of less than 1/3 of the limits used for comparison because only then can we state that the exhibited error of the instrument is significant. This discussion leads directly to the question of how close the measured value may lie in relation to the allowed limit.

The statistical answer to this question is that the deviation should not be larger than 2/3 MPE. According to OIML R 76, however, even values that fall within the limit as shown in Fig. 1 are accepted for practical reasons. In a statistical sense this implies that in 50 % of all cases the instrument has actually failed the test.

Illustrating the problem

To illuminate the problem a hypothetical situation is constructed and illustrated in Fig. 2. The example is chosen in total conformity with the demands of 3.6, 3.6.1, and 3.7.1 of OIML R 76. It is further assumed that we could work with a very high resolution (d = 1/20 e). We assume an error of ϵ = 0.4 e in the weights at a given load (larger than 2 000 e; $\epsilon \leq$ 1/3 MPE, i.e. $\epsilon \leq$ 0.5 e). Three repeated weighings with that load produce values x_i, which differ from the nominal mass with (0.45 e, 1.15 e, 1.4 e allowed $x_i \leq$ 1.5 e), leading to an average instrument error of $\epsilon \leq$ 1 e, and a repeatability range of 0.95 e.

All values are relative to the nominal mass of the weights used. Since this example clearly satisfies all the conditions stated above, the instrument should be verified as being correct.

From a statistical point of view, the left and right curves in Fig. 2 show an idealized uncertainty distribution of the load, *f(load)*, and of the instrument indication, *f(ind)*, respectively. These distributions are due to the uncertainties of the weights used and to the repeatability of the instrument.

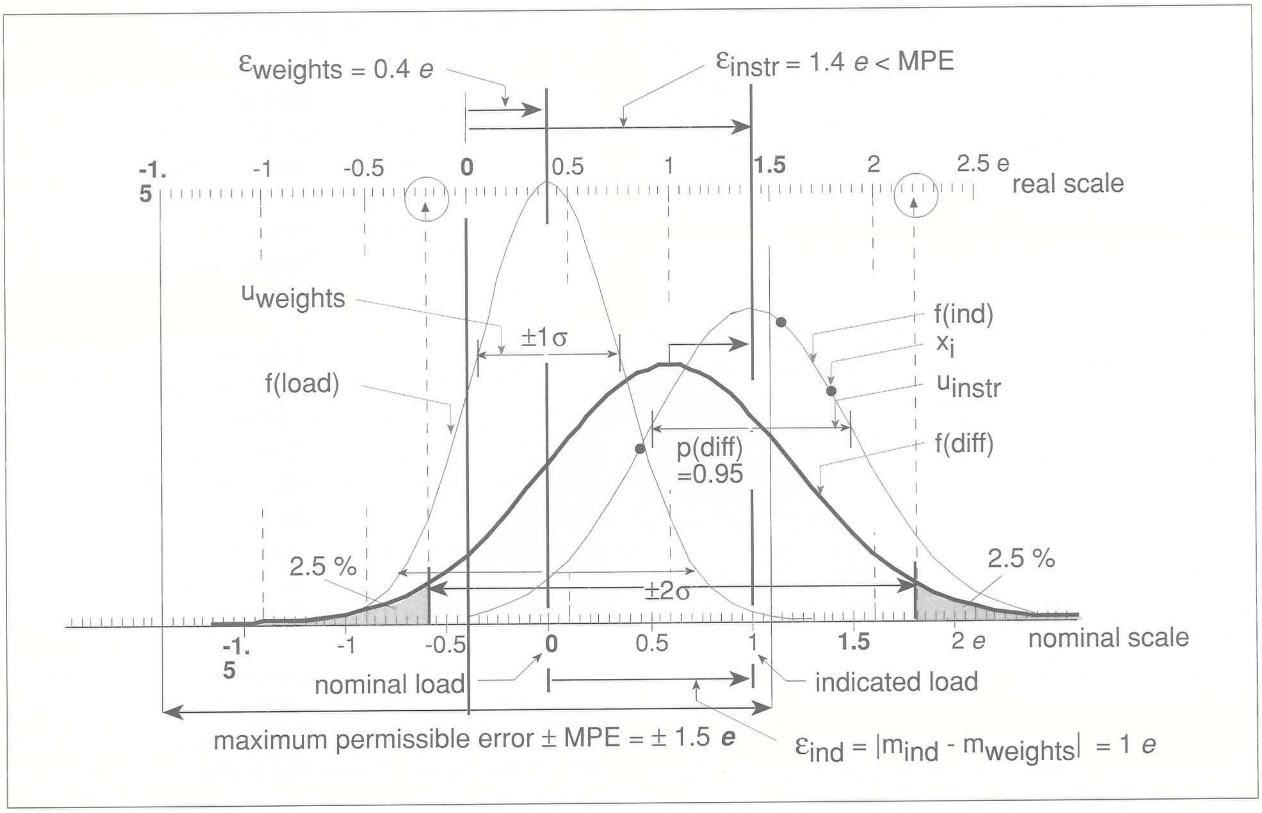

Fig. 2 A constructed example based on the assumption of a normal distribution for the uncertainty.
The demands of OIML R 76 are met but the significance level of the verification is unsatisfactory.

Both curves are centered around the nominal and indicated load. The upper graduation is in scale divisions *e* with respect to the load that is actually applied. The lower graduation represents the nominal scale, i.e. the load inherent scale. Both scales are shifted by the error $\epsilon_{weights}$.

The shaded middle curve presents the probability distribution of the difference, *f(diff)*, i.e. the statistically expected difference between the indicated and the nominal load (to be read on the real scale). All three curves are constructed as standardized normal distributions with different mean values μ and variances σ^2, but with a constant area representing the probability to cover certain values. The following table indicates the assumptions that are made:

	"ERROR" MEAN VALUE	STANDARD DEVIATION	UNCERTAINTY ± 2σ
LOADS (weights)	$\mu_w = 0.4\ e$	$\sigma_w = 0.35\ e$	± 0.7 *e*
INSTRUMENT	$\mu_i = 1.4\ e$	$\sigma_i = 0.5\ e$	± 0.1 *e*
DIFFERENCE	$\mu_d = 1.0\ e$	$\sigma_d = 0.61\ e$	± 1.2 *e*

With the assumed variances ($s_d^2 = s_w^2 + s_i^2$) the distribution of the difference *f(diff)* becomes quite broad. Using the upper real scale we could conclude that with a probability of 95 % the difference might cover values reaching from ≈ – 0.2 *e* to ≈ + 2.2 *e*, which is sufficiently more than + MPE. This is true even when the error of the weights is disregarded, i.e. whether one reads the real scale or the lower nominal scale, because in the latter case we have to shift the difference distribution with + 0.4 *e* to the right and center it at 1 *e*.

Approaching the verification situation statistically, the weighing instrument may not be verified due to the fact that values larger than 1.5 *e* can occur with a high probability.

To clear up the situation the following question may be posed: what is the largest mean deviation that the weighing instrument may display so that the instrument may be verified with a given measurement uncertainty (in our case of ± 1.2 *e* on a 95 % confidence level)? With regard to the example that has been chosen (the expectation of the + 1.5 *e* line passing outside the 95 % range) the display may not show a mean value larger than – 0.1 *e*, corresponding to 0.3 *e* on the real scale.

The hypothetically constructed example demonstrates the following: in order to verify a weighing instrument with a high level of certainty, we must not require a specified maximum error of the weights in the first place, but rather a total measurement uncertainty which corresponds to the ± 2σ value of the difference distribution.

The above reasoning does not take into account other effects that can affect the verification such as the circumstances concerning the weighing procedure, the weighing instrument, and its discrimination. Only if all these effects were negligible or added to the measurement uncertainty could one then safely state that the instrument is or is not in conformity with the defined limits.

Some suggestions for OIML R 76

The important suggestion that the authors would like to make is that the OIML Recommendation adopt a requirement stating that the total verification uncertainty may not exceed 1/3 of the maximum permissible error.

Moreover, the authors would like to suggest the use of a different perspective and terminology. The term *error* of the standard weights addresses the difference between the nominal mass and the real mass of the weights – it may be known and corrected for. The authors therefore suggest to replace the term *error* with the term *tolerance* for large weights.

Tolerances for large weights

After calibration or verification, the real masses of large weights should be known with a given uncertainty. Large weights, however, are usually adjusted to a somewhat higher value than the nominal value since they lose mass during their use. Nevertheless, in practice the standard weights are characterized only by their nominal values.

Instead of adding individual uncertainties, as shown in Fig. 3, only collective tolerances ($\pm T_i$) can be addressed to standard weights. These tolerances cover both the actual (adjusted) error *a* of the weights and the uncertainty in their calibration or verification. If a complete set of these weights is adjusted in the same way, against the same reference weight, with the same balance and at one point in time, then all tolerances must be added linearly as follows: $u_{weights} = \pm \sum |T_i|$.

Figure 3 shows that depending on the frequency of their usage, the real value of the weights will shift from the right hand side to at most the situation of the left hand side of the figure during the period before the next calibration.

Based on the following hypothetical factors:

- only weights that have a value less than the nominal value are adjusted according to Fig. 3;
- this process is repeated using a fraction of the set at a time; and
- the weights are used randomly,

one may examine a sample of weights statistically and conclude that the average uncertainty of such a weight

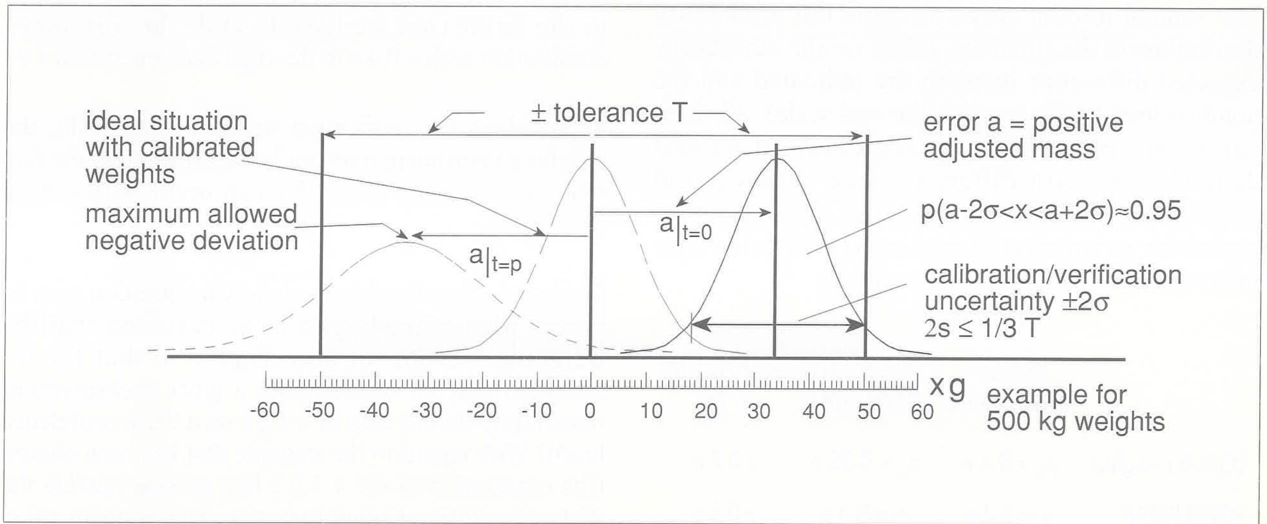

Fig. 3 Definition of the tolerance of large weight with the nominal mass, the adjusted mass at verification t = 0 and at the end of the verification period t = p.

(assuming rectangular distribution) is ± $T/\sqrt{3}$ on a 1-σ level. On a random basis and assuming that large samples are used, the positive and negative errors may be expected to be distributed symmetrically, but the total uncertainty of a sample should still be given by $u_{\text{weights}} = \pm \sum |T_i| / \sqrt{3}$.

With the requirement $U_{\text{tot}} \leq 1/3$ MPE leading to p(U_{tot}) = 0.05 MPE, we can now easily check whether or not our test is significant enough to allow a verification. U_{tot} should refer to the complete measurement uncertainty in the testing procedure and may be defined by

$$U_{tot} = 2\sqrt{u^2_{weights} + u^2_{instr} + u^2_{rest}}$$

$$U_{tot} \leq \frac{1}{3} MPE$$

with contributions from the weights, the instrument itself and a remaining quantity that takes into account the effects associated with the weighing procedure. These contributions may be given by

$$u_{weights} = \sum_{i=1}^{n} \frac{|T_i|}{\sqrt{3}} = \text{n}\frac{T}{\sqrt{3}}$$

$$u_{instr} = \frac{1}{2}\frac{R}{\sqrt{3}} = \frac{1}{2}\frac{e}{\sqrt{3}} = \frac{1}{2}\frac{d}{\sqrt{3}}$$

$$u_{rest} = \frac{1}{2}\frac{aR}{\sqrt{3}} = \frac{1}{2}\frac{ad}{\sqrt{3}}$$

where R denotes the range of repeated indications with the same load applied (50 % of Max). If the limited resolution produces R = 0, then e (or a technically enlarged scale interval d) is used to express the repeatability. The symbol a is an empirical constant that covers the differences between real and ideal conditions and expresses these differences as effects on the reproducibility of the instrument.

The three contributions are defined based on a standard probability level assuming a rectangular distribution (factor $1/\sqrt{3}$ of the measured values. The factor 1/2 changes the range to a symmetrical interval around a mean value, which is expanded to a statistical probability level (≈ 95 %) by multiplying it with a coverage factor k = 2, which is generally used in calibration [2, 3, 4].

A given test situation may be checked easily with the above formula. Assuming ideal conditions, we could once again test the significance level of the verification requirements established in OIML R 76:

(1/3 MPE = 0.5 e; $U_{\text{weights}} = \text{n}\, T/\sqrt{3} \leq (1/3) \times 1.5\, e$; $R = e$).

$$U_{tot} = 2\sqrt{\left(\frac{1}{2} n \frac{T}{\sqrt{3}}\right)^2 + \left(\frac{R}{2\sqrt{3}}\right)^2}$$

$$U_{tot} = 2\sqrt{\left(\frac{1}{2}\frac{1.5\,e}{3}\right)^2 + \left(\frac{1}{2}\frac{e}{\sqrt{3}}\right)^2}$$

$$u_{tot} \leq 0.76\, e$$

Even this simple calculation demonstrates that there is a problem concerning the OIML R 76 requirements: U_{tot} is distinctly larger than 1/3 of MPE. This is not astonishing since this amount was already occupied by the weights themselves (a comment on the factor 1/2 for the weights is necessary here: for the sake of the total uncertainty of the weights which is given in advance, this factor must be incorporated to cancel the coverage factor 2).

The use of this formula to prove the necessary significance level of a verification is demonstrated in another situation in which OIML R 76 allows for the use of a constant load under specified conditions concerning the repeatability of the weighing instrument:

§ 3.7.3 Substitution of standard weights

When testing instruments with Max > 1 t (maximum capacity), instead of standard weights any other constant load may be used, provided that standard weights of at least 1 t or 50 % of Max , whichever is greater, are used. Instead of 50 % of Max, the portion of standard weights may be reduced to:

35 % of Max if the repeatability error is not greater than 0.3 e,

20 % of Max if the repeatability error is not greater than 0.2 e.

The repeatability error has to be determined with a load of about 50 % of Max which is placed 3 times on the load receptor.

Let us examine the second situation first assuming R = 0.2 e, testing at full capacity (> 2000 e) with only 20 % in weights and 80 % of the load in tare. This situation will necessarily comprise altogether 9 weighings during which an exchange of the weights for tare will be made. The weights will be applied 5 times and the uncertainty of the weighing instrument will affect the result 9 times. The total measurement uncertainty will become:

$$U = 2\sqrt{\left(\frac{5\,n\,T}{2\sqrt{3}}\right)^2 + 9\left(\frac{0.2}{2\sqrt{3}}\right)^2}$$

$$U \leq 2\sqrt{\left[\left(\frac{1}{2}\,\frac{1}{3}\,1.5\right)^2 + 9\left(\frac{0.2}{2\sqrt{3}}\right)^2\right]e^2}$$

$$U \leq 2\sqrt{(0.063 + 0.03)\,e^2}$$

$$U \leq 0.61\,e$$

The total testing uncertainty will therefore exceed the level of 5 %. Based on the example given above, an uncertainty of the weights of less than 0.25 e (i.e. 1/2 of the allowed value) must be required in order to keep the total testing uncertainty lower than 1/3 MPE. One can conclude that if the repeatability is really as good as 0.2 e, then it is reasonable to improve the uncertainty of the weights.

With a range R = 0,3 e and 35 % of the capacity in weights, the same calculation leads to 5 weighings and a final measurement uncertainty of 0.63 e.

$$U \leq 2\sqrt{\left[\left(\frac{1}{2}\,\frac{1}{3}\,1.5\right)^2 + 5\left(\frac{0.3}{2\sqrt{3}}\right)^2\right]e^2}$$

$$U \leq 2\sqrt{(0.063 + 0.038)\,e^2}$$

$$U \leq 0.63\,e$$

Again, the standard demands of OIML R 76 will not produce a significant test until the uncertainty of the weights has been lowered from 0.5 e to at least 0.16 e.

Production uncertainty in service

Based on the calculation of the verification uncertainty, the authors would like to propose a method for specifying the in-service measurement uncertainty in a general way.

If the total measurement uncertainty can be kept below the allowed limit under ideal test conditions, then the remaining margin for errors may be reserved for other sources of error such as temperature changes, drag, shifts in time, corner loads, dirt, and handling, all of which affect the performance of the instrument.

The time interval between the initial verification and an in-service verification varies between countries, but is rarely less than one year. Therefore, during the in-service verification, the conditions for a weighing instrument are practically the same as those which exist during ordinary weighing in production. The maximum permissible error allowed in service is normally twice the MPE in initial verification. It is therefore very reasonable to accept the in-service test limits as being equivalent to that which may be referred to as the production uncertainty (Fig. 4).

If we accept that the weighing uncertainty under production conditions may be three times the uncertainty during the verification, this should cover all realistic cases. We further assume that in service, no actions are taken to correct for the indicated deviations (errors up to MPE) from a verification or from a calibration.

This situation implies that instead of directly adding the error to the verification or calibration uncertainty itself, it must be added to three times this uncertainty. The resulting sum will practically cover all weighing uncertainties and instrument errors under realistic conditions, i.e. it should not exceed the actual range for the required production uncertainty. Another way to express this idea is the following: the inner staircase in Fig. 4 sets limits for the allowed error under test (which has not been corrected for) and the range to the outer staircase establishes the remaining margin for the actual measurement uncertainty in daily production.

The authors conclude that this definition of an industrial production uncertainty might be suitable in most circumstances.

Verification and ISO-9000

The proposals mentioned above fulfil most of the prerequisites of the ISO 9000 standard concerning inspection, measurement and test equipment as argued below [5].

The requirements are, in brief, *...the supplier shall control, calibrate and maintain inspection, measuring and test equipment, whether owned by the supplier, on loan, or provided by the purchaser, to demonstrate the conformance of products with specified requirements. Equipment shall be used in a manner which ensures that* *the measurement uncertainty is known and is consistent with the required measurement capability.*

Some obligations of the supplier according to ISO 9000:

a) Identify the measurements to be made, the accuracy required and select appropriate inspection, measuring and test equipment.

b) Identify, calibrate and adjust all inspection, measuring and test equipment and devices that can affect product quality at prescribed intervals or prior to use, against certified equipment having a known valid relationship to nationally recognized standards...

c) Establish, document and maintain calibration procedures...

d) Ensure that the inspection, measuring and test equipment is capable of the accuracy and precision necessary.

f) Maintain calibration records for inspection, measuring and test equipment.

h) Ensure that the environmental conditions are suitable for the calibrations, inspections, measurements and tests being carried out.

j) Safeguard inspection, measuring and test facilities, including both test hardware and test software, from adjustments that would invalidate the calibration setting.

If an instrument that has a pattern approval based on OIML R 76 is verified according to the test procedures and if general requirements for calibration are performed (for example, all measurement results are recorded and documented in a calibration certificate), this is the best possible way to fulfil the requirements of the ISO 9000 standard for the following reasons.

- Following the proposal mentioned above, the relationship between production uncertainty and calibration is fulfilled, which is required according to (a) and (b).
- If the test procedures as mentioned above are followed, point (c) is fulfilled.

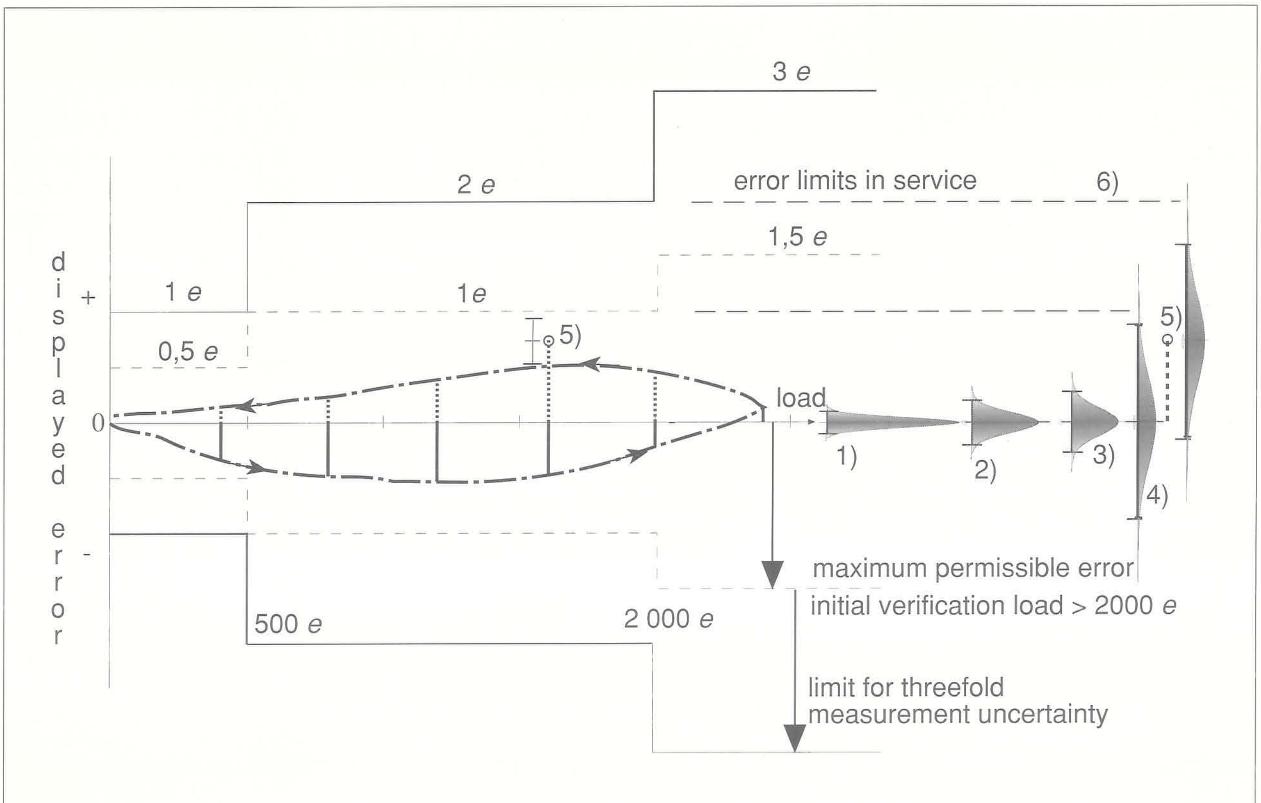

Fig. 4 Congruence of two different actions: the verification against permitted error limits, and calibration and judgement of measurement uncertainty. 1) Uncertainty contribution of weights. 2) Uncertainty contribution of the weighing instrument at 50 % of its capacity. 3) Combined testing uncertainty at accepted surrounding circumstances. 4) Threefold testing uncertainty must be within the standardized limits. 5) Instrument error at a known load, which is not corrected in service. This error and the threefold testing uncertainty are added and compared with the doubled standardized error limits (6).

- The pattern approval is a tool for ensuring that point (d) is fulfilled, since it tests the instrument stability in time; it also ensures that the first general statement in the standard is fulfilled.
- Due to the testing over different ranges of temperature and other conditions (which is mandatory in the Recommendation), the pattern approval procedure ensures that point (h) is fulfilled when the instrument is used within the limits of the pattern approval certificate.
- The requirements for securing (or sealing) in the Recommendation are sufficient for point (j).

Combining verification and calibration

The authors would like to stress the importance of subjecting weighing instruments to a verification according to OIML R 76 in combination with a calibration procedure. In addition to a certificate which only states a value for the calibration uncertainty, the combined procedure proposed in this paper would provide a well-defined limit for the measurement uncertainty in industrial production as well. This would result in a much higher reliability than a calibration *per se,* and would form a bridge between the OIML R 76 and the ISO 9000 series. By looking at testing and calibration in this manner, it may even be possible to link, in general terms, legal metrology to general metrology (OIML and ISO). ■

References

[1] OIML R 76, *Nonautomatic weighing instruments.*

[2] WECC Doc. 19-1990, *Guidelines for the Expression of the Uncertainty of Measurement in Calibrations.*

[3] ISO/TAG 4/WG 3: June 1992, *Guide to the Expression of Uncertainty in Measurement.*

[4] CIPM (1981), *Metrologia* pp. 18, 43–44.

[5] ISO-9001, *Quality systems - Model for quality assurance in design/development, production, installation and servicing.*

Gravity correction: An Italian preliminary proposal

THE INFLUENCE OF GRAVITY ACCELERATION ON WEIGHING INSTRUMENTS EQUIPPED WITH LOAD CELLS

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With electronic weighing instruments equipped with load-cells, the mass measurement is affected proportionally by "g" variations. The EC Directive 90/384 defines the rules concerning this problem. The following paper addresses the difficulties connected with the characteristics of the Italian peninsula and presents a preliminary proposal for zone-of-use division.

ALL terrestrial bodies exert a force which can be the weight force, the elastic force, or the inertial force. The weight force, however, may also manifest itself as a dynamic force. When a body is allowed to fall freely, it moves with an acceleration which is constant at a given place and which is directed towards the center of the Earth. This acceleration is referred to as acceleration due to gravity, or *gravity acceleration,* and the related force is expressed as:

Equation 1: $P = mg$

The weight force is proportional to g through the m constant, the latter being the mass of a body, i.e. a physical body property which manifests itself both in the weight force and in the inertial force. In that which concerns the inertial force, the body motion satisfies the conditions of the first and second principles of dynamics: (1) the principle of inertia, and (2) the principle concerning the proportionality that exists between the force exerted on a body and the acceleration of the body motion, which is expressed by the relation $F = ma$.

Consequently, when the force brings about dynamic phenomena, it is determined indirectly through mass and acceleration measurements. When the weight force does not cause a body to move but rather to be deformed, the force value is obtained from the relation between the force and the quantity expressing the deformation.

Measuring the weight force

Force transducers, dynamometers, or load cells are the devices that may be used for measuring weight force. Essentially, these instruments measure the mass of a body by using the gravity force which acts on such body and which is directed towards the center of the Earth. The force that is exerted on a body in the opposite direction is due to the air thrust. Both these forces, the *gravity force* and *air buoyancy,* are dependent on the value of the acceleration due to gravity.

Gravity acceleration values

The acceleration due to gravity (g), is a geophysical quantity which varies depending on geographical location; its total relative variation on the Earth's surface is equal to 0.53 % [1]. The total variation in g is due mainly to the shape and rotational movement of the terrestrial globe which is flattened at the poles and

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swelled at the equator. The variation is also a function of time, though at a very low rate.

In 1967, on the basis of researches and studies, the International Geodesy Association adopted the following formula which expresses the gravity acceleration (in m/s^2)* as a function of latitude (φ).

Equation 2:

$$g_{\varphi} = 9.780327\,(1 + 5302.4 \times 10^{-6} \sin^2\varphi - 5.8 \times 10^{-6} \sin^2 2\varphi)$$

This equation and its graphic representation in Fig. 1 demonstrate the following: a) At points far from the extreme latitudes ($\varphi = 0$ at the equator, $\varphi = 90°$ at the poles) the gradient value is:

Equation 3:

$$\frac{\Delta g/g}{\Delta\varphi} = 8.9 \times 10^{-5}\,\frac{(m/s^2)/(m/s^2)}{degree}$$

b) The gradient value is positive when moving from the equator towards the poles.

c) The gradient value decreases when moving towards the extreme latitude points.

The values of the above equation are obtained with the assumption of a regular surface (at sea level) in the form of an ellipsoid and a constant density of the Earth. Actually, g varies with altitude (i.e. when moving away from the Earth's surface) and non-uniform terrestrial density, which causes a phenomena referred to as the *Bouguer anomalies*. In a first approximation, the gradient of g can be given by the following equation:

Equation 4:

$$\frac{\Delta g/g}{\Delta h} = -\,(0.25\text{–}0.30)\ 10^{-6}\,\frac{(m/s^2)/(m/s^2)}{m}$$

which shows that:

a) the gradient sign is negative when moving upwards from sea level;

b) a relative variation in g of $(0.25\text{–}0.30) \times 10^{-6}$ corresponds to a 1 m variation in altitude.

Consequently, the g value at a given place is known if the values of latitude, altitude to sea level, and anomaly are known. This value can be expressed by an equation which gives the value of g at a given place:

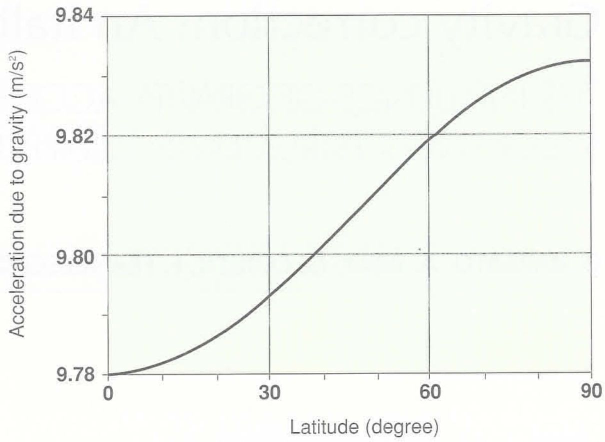


Fig. 1 Graphic representation of Equation 2: gravity acceleration as a function of latitude.

Equation 5:

$$g = g_{\varphi} + g_h + g_B$$

where:

g_{φ} = acceleration due to gravity at latitude φ and at sea level

g_h = variation in gravity acceleration due to altitude

g_B = variation in gravity acceleration due to Bouguer anomalies

The anomaly value can be determined experimentally; for the Italian territory, this value is given in the gravimetric map of Italy that was prepared by the *Servizio Geologico d'Italia* (the governmental mapping organization of Italy). This map shows that throughout the Italian territory the extreme values of Bouguer anomalies (positive or negative) cause relative variations in g in the order of 150×10^{-6} with respect to the values obtained from Equation 2.

With the use of a gravimetric map, the g value is determined on the basis of Equation 2 from which latitude can be determined with an uncertainty of 2'. This value corresponds to a contribution of 3×10^{-6} to the overall uncertainty in the determination of g, while the value of altitude with an uncertainty of 20 m corresponds to a contribution of about 5×10^{-6}. The overall relative uncertainty of the local gravity acceleration value can be statistically estimated to be lower than 10×10^{-6}.

The value of the overall relative uncertainty has been checked by comparing the values of g, which were obtained experimentally at a number of places, with

* Another measurement unit used for gravity acceleration in geodesy is the *gal*. *1 gal = 1 cm/s²*.

those given in the map. Eleven locations in Italy were considered, each with a different altitude. The average value between the two extremes of this experiment is taken as the coefficient of Equation 4. The results of the comparison show that:

a) the relative deviation between experimental and calculated values varies proportionally with altitude; and

b) a reduction in the coefficient in Equation 4 reduces deviation.

This deviation, however, is accounted for since it is due to the density (ρ) of the Earth's crust and to the topographic correction (T.C.) for the attraction or the other effects resulting from large masses (hills or mountains) and valleys surrounding the measurement site. The deviation may vary from values lower than 1×10^{-6} in ground-level zones to 30×10^{-6} in mountainous zones. If the variations for ρ and T.C. are taken into account, g at the real altitude (h) is:

Equation 6:

$$g = g_{\varphi} + g_B - 0.308\ 10^{-5}\ h + 0.042\ 10^{-8}\ \rho\ h + T.C.$$

or, with an average value of 2 400 kg/m³ for ρ :

Equation 7:

$$g = g_{\varphi} + g_B - 0.207\ 10^{-5}\ h + T.C.$$

The 0.207 factor (expressed in 10^{-5} m/s²·m) is obtained from the sum of terms 0.308 (gradient in free air) and – 0.042 ρ (attraction of the Bouguer's plate). It can be concluded that the deviation between experimental and map-determined values is significantly reduced if the 0.207 factor value (which takes altitude into account) is used.

Establishment of gravity networks

The Italian gravimetric network was established in 1953 [3] and consisted of 119 main reference points that were distributed throughout Italy (including Sicily). The gravimetric datum was connected to the Potsdam system by means of relative pendulum observations.

In 1971, the International Geodetic Association responded to the possible need for a worldwide gravity network by establishing the International Gravity Standardization Network '71 (IGSN'71) which comprises about 20 000 relative measurement points and eight absolute measurement stations where an absolute value of g may be measured. This network is distributed throughout the world (most densely distributed in Europe) and ensures a standardized reference gravimetric system. In Italy, the main IGSN'71 stations are located primarily in an ideal line from the Brenner pass to Etna.

Use of the absolute transportable gravimeter of the *Istituto di Metrologia "G. Colonnetti" (IMGC)* [1] began in 1975. As the first apparatus of its kind, the absolute transportable gravimeter was based on an analysis of the motion of a body launched vertically upwards and moving freely in the Earth's gravitational field.

During 1976–77, four stations in Italy and 13 in Europe were established. The four Italian stations as well as two others in Europe (Sèvres, France and München, Bavaria) were used as references for a new, first-order gravity network that was established in 1977 [4]. In recent years, the IMGC absolute transportable gravimeter has been used for the establishment of 15 additional stations for use in the framework of different projects.

At present, there exists the main gravity reference stations of the Italian fundamental network of 1955 (RF155) (Fig. 2), the reference stations of the IGST'71,

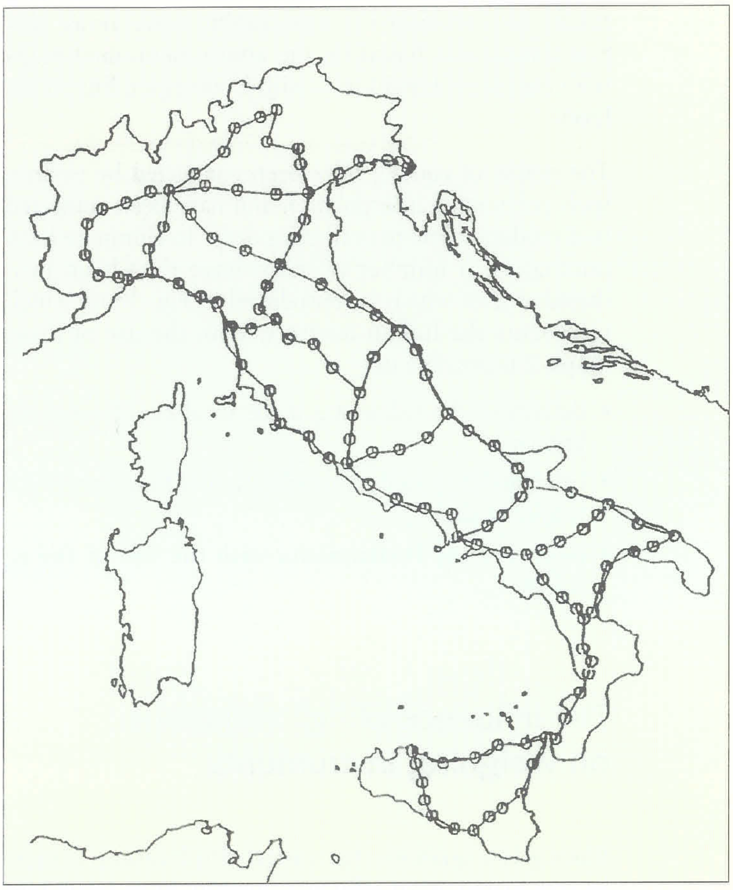


Fig. 2 The Italian Fundamental Network.

and the new Italian gravity network of 1977 which uses most of the stations already belonging to the RF155 and the IGSN'71, as well as the values of the observations carried out with the IMGC gravimeter.

A significant amount of gravity prospecting has been referred to these networks throughout the past years, thus leading to the acquisition of over 300 000 field gravimetric points. The density of these points is higher than 1 point per square kilometre in level areas, and the majority of these points are the property of AGIP (the Italian petroleum agency) and are industrially classified.

Bouguer anomalies and "g" distribution in Italy

The maps of Bouguer anomalies are unclassified and can be provided upon request by *Servizio Geologico Italiano* in analogic and digital forms (grid of 3 km × 3 km) as well as by the *Bureau Gravimetrique International.* Following a request by the *Ufficio Centrale Metrico* of the Ministry of Industry, Cerutti and Marson [5] have re-calculated the distribution of g taking into account the topographic corrections; this calculation was based on the above mentioned maps with the use of Equation 5, with h corresponding to sea level.

The points of equal g have been connected by isolines with polynomial interpolation and have been subjected to a moderate low-pass filter in order to eliminate local anomalies. A number of maps have thus been produced, one of which is reproduced in Fig. 3 and which represents the Italian territory. With the use of these maps, it is possible to:

- determine the value of g if the local coordinates are known,
- calculate the g value by application of Equation 7, if h is known, and
- calibrate the instruments with the use of the g_h values.

The influence of "g" variations on weighing instruments

Since g is a quantity that varies with location, it must be considered as an influence quantity to be taken into account whenever its variation is of a magnitude

Table I Accuracy classes of weighing instruments and their symbols.

ACCURACY CLASS	SYMBOL
Special	(I)
High	(II)
Medium	(III)
Ordinary	(IIII)

similar to that of the accuracy of the weighing system concerned. The quality of a system is determined on the basis of its accuracy class. In accordance with specification standards, weighing instruments are divided into four classes and are denoted by symbols on the basis of their accuracy level as shown in Table I.

The mentioned criteria have been taken into account by the EC regulations which have been introduced into the Italian legislation by means of the DPR no. 157 of 29 Dec 1992. This Act concerns *"the enforcement of the EC Directive 90/384 on the harmonization of the regulations of the member states concerning nonautomatic weighing systems"* and went into effect as of 1 Jan 1993. On the basis of Annex II (paragraphs 5.1 and 5.2) of the EC regulations (90/384/EC), it is established that:

§ 5.1 The EC declaration of type conformity (guarantee of production quality), the EC verification, and the EC unit verification may be carried out at the manufacturer's work or any other location if transport to the place of use does not require dismantling of the instrument, if the taking into service at the place of use does not require assembly of the instrument or other technical installation work likely to affect the instrument's performance, and if the gravity value at the place of putting into service is taken into consideration or if the instrument's performance is insensitive to gravity variations. In all other cases, they shall be carried out at the place of use of the instrument.

§ 5.2 If the instrument's performance is sensitive to gravity variations the procedures referred to in 5.1 may be carried out in two stages, where the second stage shall comprise all examinations and tests of which the outcome is gravity-dependent, and the first stage all other examinations and tests. The second stage shall be carried out at the place of use of the instrument. If a Member State has established gravity zones on its territory the expression "at the place or use of the instrument" may be read as "in the gravity zone of use of the instrument".

Some further considerations

In that which concerns the variations in g, the following cases may occur:

Case 1 Instrument accuracy is lower than the relative variation due to the influence of g on the instrument; in this case the instrument can be calibrated at the place of instrument use or manufacture.

Case 2 Instrument accuracy is higher than the relative variation due to the influence of g on the instrument; in this case the instrument can be calibrated at the place of instrument use, or manufacturer site provided that a correction is introduced which takes into account the gravity acceleration value at the place of use.

Case 2.1 If a Member State has established "zones of use" within its territory in connection with gravity, the phrase "at the place of instrument use" can be understood as "within the gravity zone of instrument use".

Case 2.2 If the instrument is equipped with a self-compensating device, it can be calibrated at either the place of instrument use or manufacture.

In Case 1, the instruments are tested at either the place of construction or the place of use; masses of adequate precision are employed. In Case 2, after the instrument is calibrated at the manufacturer site (where the gravity acceleration value is g_1), the measurement values are corrected in function of the known gravity acceleration value g_2 at the place of use; this is effected with the application of the ratio:

$$r = g_2/g_1$$

In such cases, the instrument can be re-calibrated, provided that two conditions are satisfied: a) the value of g at the installation place is known, and b) re-calibration is carried out in the presence of an officer of the national Legal Metrology System.

Cases 2.1 and 2.2 concern transportable weighing instruments; the instruments to be used in commercial transactions fall into this category. As already mentioned, the procedures concerning the first three cases are included in the EC regulations.

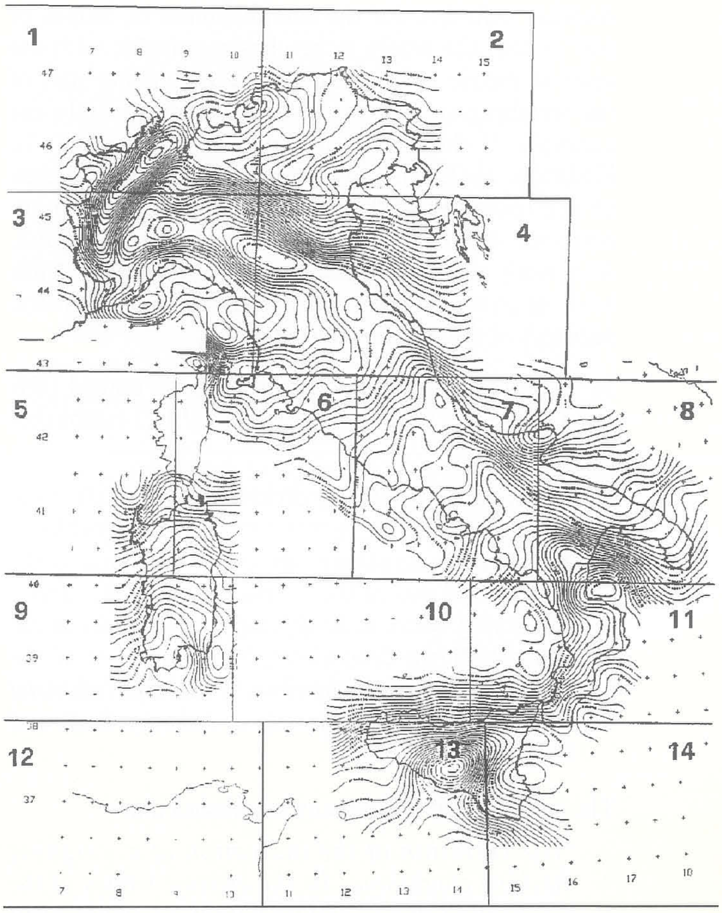


Fig. 3 Map of isolines of equal g value throughout the Italian territory.

Defining a zone of use

A *zone of use* can be defined as a portion of a state territory where variations in g are lower than the variations occurring over the whole territory and where the free circulation of the weighing systems of the higher accuracy class is allowed. Each *zone of use* is identified by maximum, mean, and minimum values of the acceleration due to gravity in the portion of the territory considered. Since reference is made to these values, it is unnecessary to know the value at the place of installation.

Criteria for the establishment of zones of use

The number of zones to be established is related to the variations in g over the whole territory in the following sense: the greater (or smaller) the g variation is, the more (or the less) numerous the zones will be, so as to avoid high g variations.

Another criterion for the establishment of "zones of use" is that the places to be chosen coincide with the seats of metric inspectorates, since the greater part of the weighing systems are used for trade. In Italy, for example, if the seat of a metric inspectorate is in Piedmont, the latter is to be completely part of one zone of use (possibly with other adjacent regions) in accordance with the territorial division into zones of use. As already mentioned, the choice of the zones of use and, in general, the *g* variation are related to the accuracy of the weighing instrument.

In connection with the zones of uses, the quoted DPR no. 157 Act (sections 5.2, 5.2.1 and 5.2.1.1) establishes the following:

> *"The national territory is divided - on the basis of the maximum relative error which is allowable in instrument indications and which is related to the applied load and to the instrument accuracy class - into gravity zones to be defined, on the advice of the Central Metric Committee, by regulations of the General Direction of the Home Trade and Industrial Consumption of the Ministry of Industry Trade and Craftsmanship."*

The rule adopted in Germany establishes that:

> *"The variation of the indication of a weighing machine conditioned by the extreme values of the acceleration due to gravity within an employment zone does not exceed more than ± 1/2 of the absolute value of the mean error limits on verification (arithmetic mean over the integral of the error limit)"* [6, 7].

In Case 2.2 presented above, the effects of *g* are compensated for by comparing the measurement signal with a reference signal that takes the *g* variation into account. This signal is obtained by using a compensating device inside the measuring apparatus.

Permissible error in weighing instruments

The permissible error for initial verification is given in Table II with reference to the accuracy class and within the measurement range of the system; this is represented in the diagrams in Figs. 4a and 4b. The values are given for the high- and medium-accuracy classes which are of particular interest in that which concerns the influence of the acceleration due to gravity.

For the medium-accuracy class, the permissible error is given as an absolute value in Fig. 4a and is expressed in a number of divisions. For the high- and medium-accuracy classes, this permissible error is given in Fig. 4b as a relative value.

The weighing systems of accuracy class IIII have up to 1 000 divisions and the gravity acceleration value does not concern them because the relative difference between the highest and the lowest *g* values is about 0.1 % in Italy and Germany. Weighing systems of accuracy class I have more than 100 000 divisions. Owing to their high sensitivity, such systems require a calibration at the place of use by using standard weights of adequate accuracy.

Consequently, as regards compensation for the effects of *g*, only the systems belonging to high- and medium-accuracy classes are considered here. In accordance with the German legislation, such systems "must bear the mark of the zone where the verification has validity, if their number of divisions is higher than 1 000 and 3 000, respectively".

Table II Measurement ranges and permissible errors of weighing systems. e: verification division, equal to actual division d for all instruments not equipped with complementary indicators.

Maximum permissible errors on initial verification	For loads m expressed in verification scale intervals e			
	class (I)	class (II)	class (III)	class (IIII)
± 0.5 e	0 ≤ m ≤ 50 000	0 ≤ m ≤ 5 000	0 ≤ m ≤ 500	0 ≤ m ≤ 50
± 1 e	50 000 < m ≤ 200 000	5 000 < m ≤ 20 000	500 < m ≤ 2 000	50 < m ≤ 200
± 1.5 e	200 000 < m	20 000 < m ≤ 100 000	2 000 < m ≤ 10 000	200 < m ≤ 1 000

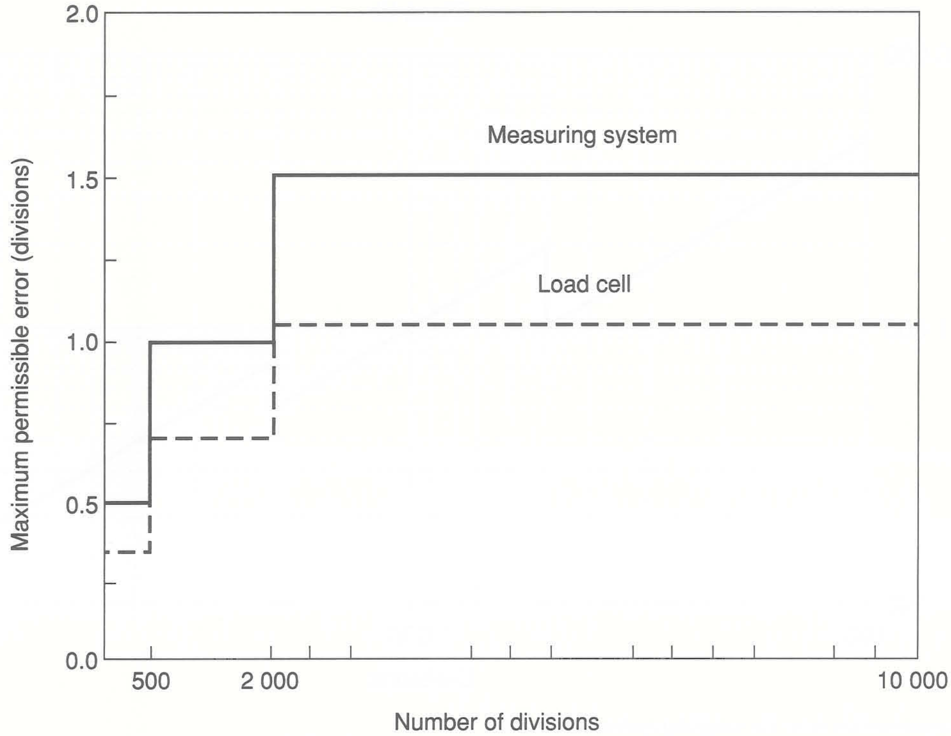


Fig. 4a Permissible error in weighing systems: absolute errors for weighing systems of class III.

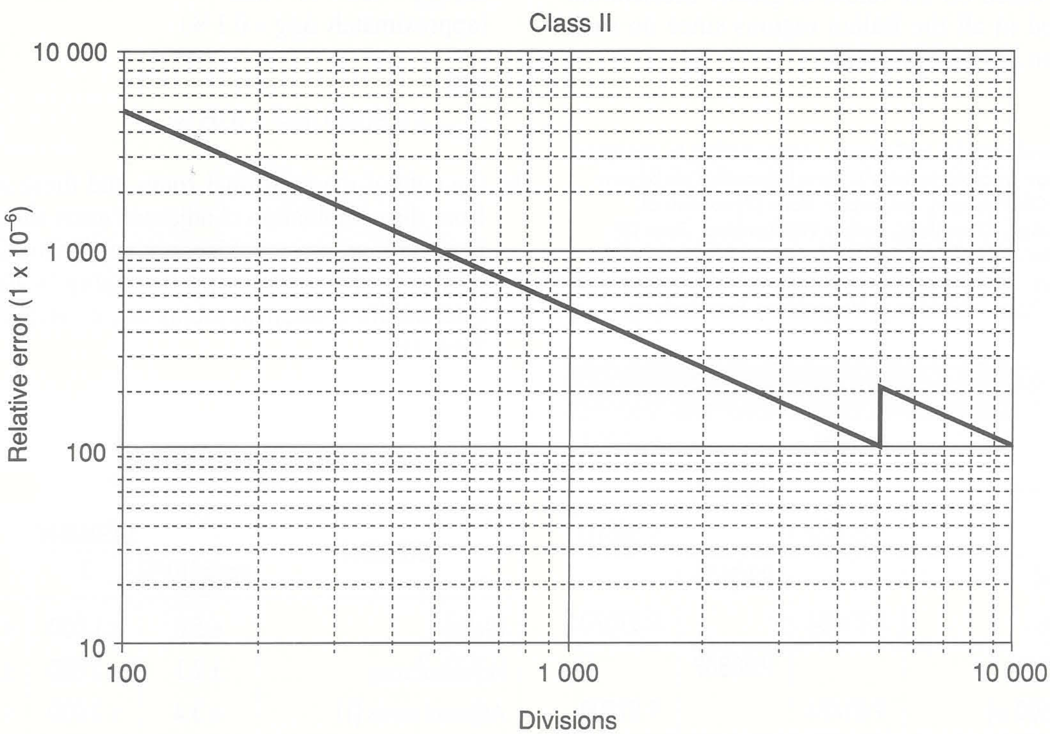


Fig. 4b-1 Relative permissible error for weighing systems of class II.

Fig. 4b-2 Relative permissible error for weighing systems of class III.

Examples of zone of use division

The following two examples show how zones of use can be determined. The first example concerns the German territory which has been divided into four zones of use by the national legal metric authorities. The second example is based on the values of gravity acceleration as measured in all the Italian regions since no such zone division has yet been made.

Table III Names of places and altitudes in Germany corresponding to maximum, minimum, and mean g values (in m/s^2). Zone (1) consists of: Bayern-Sud (Nieder- und Oberbayern), Schwaben. Zone (2) consists of: Bayern-Nord (Franken, Oberpfalz), Baden-Württemberg. Zone (3) consists of: Nordrhein-Westfalen, Saarland, Hessen, Rheinland-Pfalz, Thüringen, Sachsen. Zone (4) consists of: Schleswig-Holstein, Hamburg, Bremen, Niedersachsen, Meklenburg-Vorpmmern, Brandenburg, Sachsen-Anhalgt.

ZONE	PLACE	g_{max}	g_{min}	g_{mean}
1	Mittenwald (913 m)	9.80869		9.80700
	Furt in Wald (410 m)		9.80524	
2	Neustadt (828 m)	9.81022		9.80810
	Würzburg (180 m)		9.80608	
3	Pirmasens (368 m)	9.81264		9.81070
	Espelkamp (40 m)		9.80889	
4	St Andreasberg (600 m)	9.81494		9.81300
	Flensburg (0 m)		9.81111	

Table III gives the data concerning each of the zones in Germany and the whole German territory. The values in question are g_{max}, g_{min} and g_{mean} [8]. This table also shows that:

a) over the whole German territory:
$(\Delta g)_{max} = 962 \times 10^{-5}$ m/s^2
(approximately $\Delta g/g$ = 0.1 %)

and

g_{mean} = 9.81000 m/s^2 ± 0.05 %;

b) the data of the individual zones and those resulting from the combination of adjacent zones show that it is possible to use weighing systems having different numbers of divisions and belonging to the high- and medium-accuracy classes, as indicated in Table IV.

Table IV Weighing system and number of divisions to be used in individual and adjacent zones in Germany.

DIVISION	GERMANY		
	$\Delta g/g$ (10^{-4})	II	III
Global	± 5.0	≤ 1 000	≤ 3 000
Individual zone	± 2.1	≤ 3 300	≤ 10 000
Adjacent zones (1)	± 3.4	≤ 2 000	≤ 5 000

(1) Maximum values: Germany, zones 3 and 4.

A preliminary proposal for a zone of use division in Italy

For Italy, a tentative zone of use division is proposed as an analogy of that which has been done in Germany and on the basis of the stated criterion adopted for that country [6]. For this tentative division, the measured maximum and minimum values of g and the mean values of all Italian regions (Table V) will be used.

Table VI lists the names of the places corresponding to the maximum and minimum values. These values do not reflect those of the extreme measurement points (for example, the top of a mountain), but those of the places in which weighing systems can be used.

By combining the values of g in the different regions, a division of the Italian territory into five zones of use has been hypothetically considered. As shown in Table V, the individual zones denoted by letters A to E may include one region (as is the case with Valle d'Aosta and Sicily) or a number of regions.

On the basis of the relative variations of g in the individual zones, in adjacent zones and throughout the whole territory, the number of divisions for weighing systems of the high and medium classes have been determined. Table VII shows the relevant data.

Table V Maximum, minimum, and mean values of g (in m/s^2) of the Italian Regions.

ZONE	REGION	g_{max}	g_{min}	g_{mean}
A	Valle d'Aosta	9.80591	9.80164	9.80378
B	Piemonte	9.80531	9.80426	9.80479
	Liguria	9.80565	9.80482	9.80524
	Lombardia	9.80630	9.80340	9.80485
	Veneto	9.80644	9.80616	9.80630
	Trentino A.A.	9.80620	9.80490	9.80555
	Friuli	9.80655	9.80651	9.80653
	Emilia Rom.	9.80589	9.80390	9.80490
C	Toscana	9.80532	9.80414	9.80473
	Umbria	9.80398	9.80380	9.80389
	Marche	9.80460	9.80357	9.80409
	Lazio	9.80398	9.80269	9.80334
D	Abruzzo	9.80354	9.80159	9.80256
	Molise	9.80352	9.80352	9.80352
	Campania	9.80285	9.80076	9.80181
	Puglia	9.80350	9.80214	9.80282
	Basilicata	9.80199	9.80059	9.80128
	Calabria	9.80137	9.79989	9.80063
	Sardegna	9.80268	9.80039	9.80154
E	Sicilia	9.80104	9.79642	9.79873

Table VI Names and altitudes of places corresponding to maximum and minimum values of g (m/s^2).

ZONE	PLACE	g_{max}	g_{min}	g_{mean}
A	Pont-Saint-Marin (310 m)	9.80591		9.80378
	Breuil (2 024 m)		9.80164	
B	Cervignano (8 m)	9.80655		9.80497
	Ponte di Legno (1 260 m)		9.80340	
C	Massa (50 m)	9.80532		9.80400
	Bivio Subiaco (390 m)		9.80269	
D	Torino di Sangro (6 m)	9.80354		9.80171
	Bivio Colosimi (766 m)		9.79989	
E	Milazzo (0 m)	9.80104		9.79873
	Etna (1 750 m)		9.79642	

Table VII Weighing system and number of divisions to be used in individual and adjacent zones in Italy.

DIVISION	ITALY		
	$\Delta g/g$ (10^{-4})	II	III
Global	± 5.1	≤ 1 000	≤ 3 000
Individual zone	± 2.2	≤ 3 000	≤ 8 000
Adjacent zones (1)	± 3.6	≤ 2 000	≤ 5 000

(1) Maximum values: Italy, zones D and E.

A comparison with the data in Table IV shows that:

1) with a division of the Italian territory into five zones, the weighing systems to be used in practice are in alignment with those employed in Germany (where the territory is divided into four zones of use);

2) although the overall variation in g is the same in these two countries, the reason for the higher number of zones in Italy lies in the orographic configuration of the country.

As already pointed out, the present proposal is preliminary and is based on some of the criteria that have been indicated; other possible proposals can be examined by the relevant authorities, in particular by those of the Central Metric Bureau of the Ministry of Industry which is responsible for legal metrology within the Italian territory. ■

References

[1] Bray A., Barbato G., Levi R., *Theory and practice of force measurement*. Cap.III, Academic Press (1990).

[2] Servizio Geologico d'Italia; Organo Cartografico dello Stato; Carta Gravimetrica d'Italia Scala 1:1 000 000.

[3] Cunietti M., Inghilleri G., *La Rete Gravimetrica fondamentale Italiana*. Memorie Commissione Geodetica Italiana,n.8 (1955).

[4] Marson I., Morelli A., *First order gravity net in Italy*. Bolletino di Geodesia e Science Affini. Anno XXXVII,n.4,pp.659-689 (1978).

[5] Cerutti G., Marson I., *La conoscenza della gravità in Italia*. Rapporto Tecnico (1993). Dip.Ingegneria Navale, del Mare e per l'Ambiente; Univ. di Trieste - Instituto di Metrologia "G.Colonnetti" del CNR, Torino.

[6] Kochsiek M., Wünsche W., *"The testing of weighing machines dependent on the acceleration due to gravity"*, OIML Bulletin no. 80. pp.10-17 (Sept.1980).

[7] Physikalisch-Technische Bundesanstalt (PTB). *German regulations for verification of weighing instruments whose indication depends on the local value of gravitation*. Private Communication (1993).

[8] Physikalisch Technische Bundesanstalt (PTB), Gesch. Nr.32-23 312/78. *Eichtechnische Prüfung von Waagen der Genauigkeitsklasse II und III, deren Messergebnis vom Wert der örtlichen Falbeschleunigung abhänging ist. Eichtechnische Prüfung an einem anderen Ort ams dem Gebrauchsort*. (1978).

Traceability in plane angle measurements

METHODS OF REPRODUCTION OF PLANE ANGLE UNITS

OIML Reporting Secretariat
SP 4-Sr 5: Poland*

The former OIML Reporting Secretariat SP 4-Sr 5 began work on the drafts of the OIML International Documents "Hierarchy scheme for angle measuring instruments" and "Methods of reproduction of plane angle units" in 1976. These drafts were then sent to the former OIML Pilot Secretariat SP 4 (Hungary) in 1984 and 1988 respectively.

The Secretariat received many proposals for the elaboration of one document that would include both texts. Following a decision by the Secretariat and with the approval of OIML TC 7 which is now responsible for this subject, this draft will not be published as an OIML International Document, and therefore has been adapted for publication in the OIML Bulletin.

1 Field of application

THE present document establishes the methods for the reproduction of plane angle units: **degree (°), minute (') and second (").** An illustration of the use of these methods is given on page 27 in the form of a hierarchy scheme presenting the transmission of plane angle units from primary standards to ordinary instruments.

2 External conditions for the reproduction of plane angle units

The reproduction of plane angle units must be carried out in a place which has an ambient temperature of 20 °C ± 2 °C and a relative humidity which does not exceed 65 %. Change of temperature during the measurement should not exceed 0.2 °C.

3 Methods for the reproduction of plane angle units

In principle, the reproduction of plane angle units is carried out either by uniform division and calibration of a circle division or through the determination of the ratio of two lengths according to a definite mathematical function.

Two different methods are applied for the calibration of a circle division [6, 14]:

Method 1: The comparison of definite divisions of the circle division with one (or more) fixed test angle(s) [11, 12, 24].

Method 2: The comparison of definite divisions with a second circle division by applying a different relative position [8, 14].

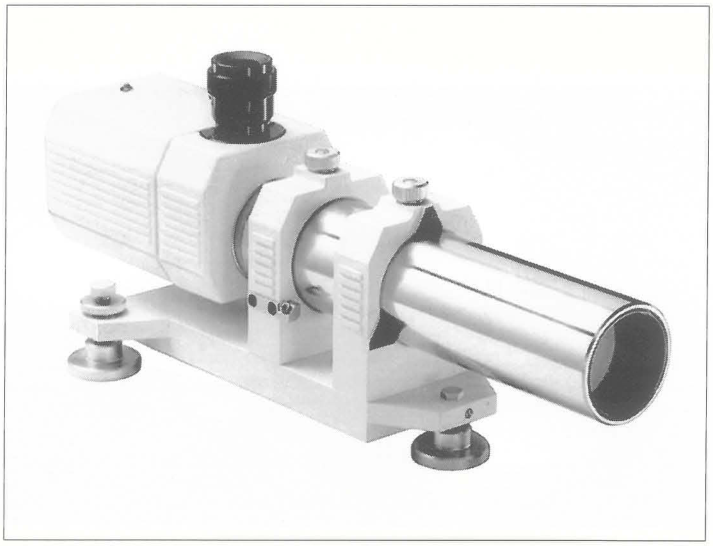


Fig. 1 Photoelectronic autocollimator.

* Former OIML technical structure; the work of OIML SP 4-Sr 5 is now under the responsibility of OIML TC 7 (UK).

There are different ways for carrying out the first method, for example by choosing different test angles with different technical constructions (two autocollimators or two microscopes).

There are also alternative ways to carry out the second method, for example by using different constructions of the two circle divisions (for example: two optical polygons, one optical polygon and one circle dividing table).

Of course, other methods may be employed by adding a third circle division (three-rosette method); nevertheless, even in such case, the division errors of a circle division are also determined methodically by the comparison with another cycle division.

The variations that are applied in the use of these methods are described in the following sections.

3.1 Reproduction of plane angle units based on standards constituted by optical polygons

The reproduction of plane angle units is carried out by means of a calibration station which is designed for calibrating optical polygons.

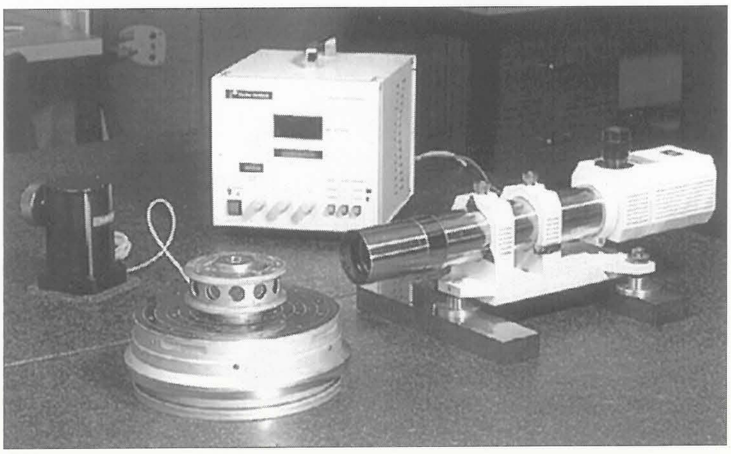


Fig. 2 A precision index table is used in conjunction with an autocollimator to calibrate a polygon.

MAIN ELEMENTS OF A CALIBRATION STATION FOR OPTICAL POLYGONS

- **Base-plate**
- **Rotating table for regulation and rotation of optical polygons**
- **Two photoelectric autocollimators which form a reference angle or one autocollimator associated with a precision dividing table (used as a reference circle division)**
- **Instruments for recording results**

3.1.1

Optical polygons used as standard instruments must meet the following requirements:

- Admissible deviation of working angle from nominal value: within ± 5"
- Admissible deviation of measurement surface from the perpendicular to the lower base: ≤ 20"
- Admissible deviation in parallel with the lower and upper base: within 5 µm to 12 µm
- Admissible deviation in flatness of measurement surface: ≤ 0.1 µm,
- Admissible deviation in flatness of upper and lower base: within 2 µm to 6 µm (no convexity)
- Eccentricity of the hole: ≤ 0.1 mm
- Width of measurement surfaces: ≥ 12 mm

3.1.2

The rotating table used in the calibration station must ensure stability of the rotation shaft to within 2".

3.1.3

The photoelectric autocollimator used in a calibration station must meet the following requirements when a digital voltmeter is used:

- Minimum graduation: 0.01"
- Measurement range: 10"

- The scales or the analog output of the autocollimators must be calibrated using a small angle generator (Fig. 4).

3.1.4

The precision dividing table used in a calibration station must meet the following requirements:

- Adjustment accuracy: ≤ 0.05"
- Instability of the rotation shaft: ≤ 2"

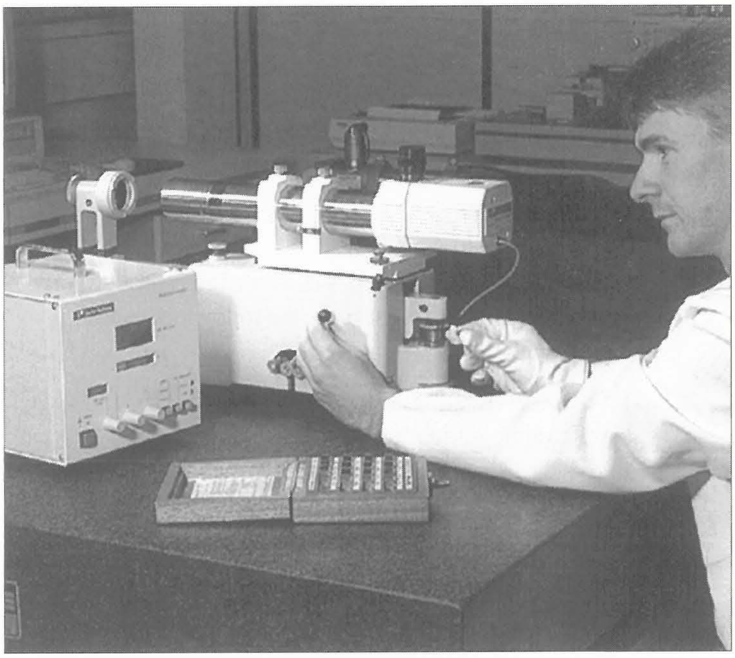
3.1.5

The commonly applied methods for the reproduction of plane angle units for optical polygons are the following (Fig. 4):

- The **"direct" method** which consists of calibrating a single optical polygon, using a rotating table and two autocollimators. Detailed descriptions of this method appear in the referenced publications [4, 5, 6, 25].
- The **"rosette" method** which consists of a simultaneous calibration of two optical polygons, using the rotating table and two autocollimators. Detailed descriptions of this method appear in the referenced publications [6, 18].
- The **"rosette" method** which consists of a simultaneous calibration of the optical polygons and precision dividing table which replaces the lower optical polygon and rotating table. Detailed descriptions of this method appear in the referenced publications [6, 18].
- The **"three rosette" method** which consists of a simultaneous calibration of two precision dividing tables and one optical polygon, using a single autocollimator. A detailed description of this method is given in the publication in reference [8].

3.2
Reproduction of plane angle units based on standard circular line scales

The reproduction of plane angle units is carried out by means of a calibration station designed for the calibration of circular line scales.



Courtesy of Rank Taylor Hobson

Fig. 3 An NPL-designed small angle generator used with traceable gauge blocks to calibrate an autocollimator.

3.2.1

Standard circular line scales used as working standards must meet the following requirements:

- Error of angular distance from the zero to any other mark: within ± 1"
- Admissible deviation in flatness of surface: ≤ 1.5 μm
- Circular scale concentricity with riggingorifice: ≤ 0.3 mm

MAIN ELEMENTS OF A CALIBRATION STATION FOR CIRCULAR LINE SCALES

- **Base-plate**
- **Rotating table for calibration and regulation of circular line scales**
- **Two or four photoelectric microscopes (according to the method applied)**
- **Instruments for recording data**

3.2.2

The rotating table used in the calibration station and designed for calibrating and regulating the circular line scales must ensure stability of the rotation shaft to within 2".

3.2.3

Photoelectric microscopes used for the reproduction of plane angle units must meet the following requirements:

- Measurement range: at least ± 10 µm
- Reading graduations: ≤ 0.01 µm

3.2.4

The commonly applied methods for the reproduction of plane angle units of circular line scales are the following (see also Fig. 4):

- The **"direct" method** which consists of examining the scale of each individual circular line scale using a rotating table and four photoelectric microscopes. Detailed descriptions of this method are given in the referenced publications [6, 11, 12, 19, 22].
- The **"rosette" method** which consists of examining the scales of two circular line scales simultaneously using a rotating table and two photoelectric microscopes. Detailed descriptions of this method are given in the referenced publications [6, 18, 26].
- The **"rosette" method** which consists of a simultaneous calibration of a circular line scales and a precision dividing table. The precision dividing table replaces the lower circular line scale and rotating table. Detailed descriptions of this method are given in the referenced publications [6, 18, 26].
- The method of **"comparative calibration of the single circular line scale"** which consists of using a rotating table, optical polygon, two photoelectric microscopes and one autocollimator. Detailed descriptions of this method are given in the referenced publications [6, 18, 24].

3.3 Reproduction methods of plane angle units using interferometers (Fig. 4)

The reproduction methods for plane angle units can usually be carried out within a limited range by using the interferometric techniques at a given wave-length.

3.3.1

Interferometers used for the reproduction of plane angle units must meet the following requirement:

- Measurement uncertainty: within ± 0.05".

3.3.2

The reproduction methods of plane angle units, using an interferometric system are described in the technical sources [5, 7, 8, 10, 13, 16, 17, 20, 21, 23, 24].

3.4 Reproduction of small angles (Fig. 4)

The reproduction of small angles for calibration autocollimators of high accuracy and sensitivity is based on the derivation of angle values by the ratio of two lengths. This is usually done either by using trigonometrical functions or by using the ratio of the length of the arc of a circle to the length of the radius of a circle.

The uncertainty of the reproduction of small angle units must be in the order of 0.05".

A description of this method is given in the referenced publications [1, 2, 3, 5, 14, 15].

4 Hierarchy scheme for angle measuring instruments

4.1 General

This hierarchy scheme presents the transmission of plane angle units from the primary standard to ordinary measuring instruments (Fig. 4).

4.2 Primary standard

A set of devices is placed at the top of the hierarchy scheme for the reproduction of angle units. In principle, the reproduction is carried out by calibrating a closed circular scale (full circle), provided that the

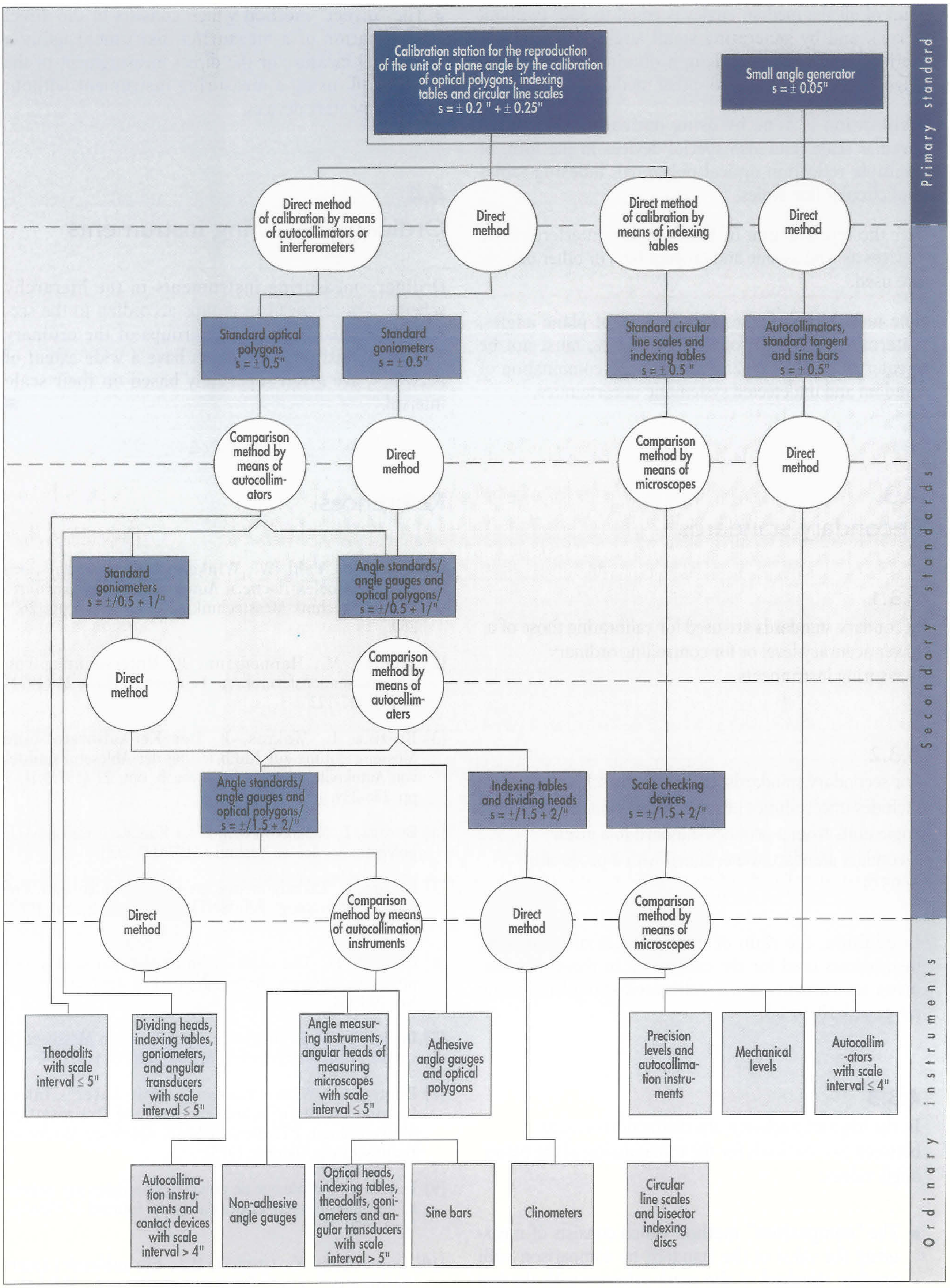


Fig. 4 Example of hierarchic system for angle measuring instruments.

sum of all the median angles is equal to 360° (without error), and by generating small angles by means of defined proportions of length obtained by applying trigonometrical relations or other methods.

Calibration is done by using optical polygons as a circular scale (and also special devices in the form of multiple reflection optical polygons), indexing tables and circular line scales.

For the reproduction of small angles, interferometric devices as well as sine and tangent bars or other devices are used.

The uncertainty of the reproduction of plane angles, determined with a probability of 95 %, must not be greater than 0.2" to 0.25" which is the combination of random and undetected systematic uncertainties.

4.3 Secondary standards

4.3.1

Secondary standards are used for calibrating those of a lower accuracy level or for controlling ordinary measuring instruments.

4.3.2

For secondary standards, the hierarchy scheme includes uncertainties of the transmission of plane angle units from a primary standard to a given secondary standard (determined with a probability of 95 %).

In addition, the ratio of uncertainties of measuring instruments used for the calibration to those of measuring instruments being calibrated should be in the range of 1/10 to 1/3.

4.3.3

In the hierarchy scheme, the distinction is made between two methods for the transmission of the plane angle values:

- The **"comparison" method** which consists of measuring the value of the standard by comparison with another standard of the same category with the use of appropriate measuring devices.
- The **"direct" method** which consists of the direct verification of a measuring instrument using a material measure or the direct measurement of the standard, using a measuring instrument without supplementary devices.

4.4 Ordinary measuring instruments

Ordinary measuring instruments in the hierarchy scheme are arranged in groups according to the secondary standards used. The groups of the ordinary measuring instruments, which have a wide extent of accuracy, are given separately based on their scale interval. ■

References

[1] Beyer, W., Pahl, W., Winkelmesseinrichtung zum Prufen fotoelektrischern Autokollimationsfernrohre. Feinwerktechnik-Messtechnik 82 (1974) H. 6 pp. 267-269.

[2] Bienias, M., Hannemann, J., Untersuchung von Autokollimationsfernrohren. Feingeratetechnik 20 (1971) H. 3 S. 117-122.

[3] Brezina, I., Mokros, J., Der Keilkalibrator-eine Messeinrichtung zur Kalibrierung der Ablesehilfsmilttel von Autokollimatoren. Jemna mech. opt. 21 (1976) H. 8 pp. 236-239.

[4] Brezina, I., Niekolko Pozmok ku Kalibracii etalonovych polygonnov. Merova Technika (1974) C. 2/23.

[5] Brezina, I., Zaklady metrologie uhlov (Fundamentals of Angular Metrology), Alfa/SNTL Bratislava, Praha, 1982, p. 216.

[6] Cook, A. H., The calibration of circular scales and precision polygons. British Journal of Applied Physics, No. 10/1954.

[7] Debler, E., Winkelinterferometer mit einem Messbereich von 95°, Feinwerktechnik u. Messtechnik 85 (1977) 4.

[8] Debler, E., Winkelmessungen mit Laser - Interferometern, Mehrfachreflexionen und Dreirosetten-Messverfahren. PTB Bericht Me-8, Abteilung Mechanik, Braunschweig, Oktober 1975.

[9] Delisle, V., Etalonnage de polygones optiques par intérférométrie en lumière laser. Canadian Journal of Physics, No.1/1970.

[10] Dorenwendt, K., Grunert, H.J., Ein zahlendes Interferometer zur Bestimmung von Winkeln, Feinwerktechnik u. Messtechnik 84/1976/7.

[11] Ejdinov, V. I., Izmerenie uglov v masinostroenii, Standartgiz 1963.

[12] Forstner, G., Zur Wahl des Prufwinkels bei dem Kreisteilungsprufverfahren nach Heuvelink. Zeitschrift für Instrumentenkunde No. 9/1964.

[13] Gliwinski, J., Ein Laser-Interferometer für Winkelmessung Feingeratetechnik, Heft 3/1978, pp. 118-119.

[14] Hannemann, J., Bienias M., Miethling K.d., Erfahrungen beim Aufbau eines Winkeletalons, Feingeratetechnik 27 (1978) H. 3 pp. 114 - 118.

[15] Jablonski, R., Toyama A., Calibration of Photoelectric Autocollimator with a Laser-Interferometer-System and Microcomputer, Bull. res. Lab. Prec. Mech. and Electronics 43 (1979), pp. 29 - 32.

[16] Marzelf, J., Interferometric calibration of X-ray Spectrometer, Bull. Ann. Phys. Sec. 7 (1962), p. 339.

[17] Mintrop, H., Debler, E., Interferometrische Winkelmessungen in grossen Messbereichen, Feinwerktechnik u. Messtechnik 85 (1977) 2.

[18] Noch, R., Steiner, O., Die Bestimmung von Kreisteilungfehlern nach einem Rosettenverfahren. Zeitschrift für Instrumentenkunde No. 2/1961.

[19] Noch, R., Reiner, W., Untersuchungen an dem Winkelmesskomparator der Physikalisch-Technischen Bundesanstalt (PTB), 7 August 1974.

[20] Saunders, J., A Height-Sensitivity Interferometer for Measurement Phase Shift and other Applications. Metrologie of Gage Blocks, U.S. Department of Commerce, NBS Circular (1957) No. 581.

[21] Saunders, J., Suggested Arrangement of Mirrors to Form Multiple Reference Angles. IOSA 51 (1961), p. 859.

[22] Schreiber, O., Untersuchung von Kreisteilungen mit zwei und vier Mikroskopen, 2 Instr. 6 (1886), pp. 1 - 5, 47 - 55 and 93 - 104.

[23] Sugg, R., An Improved Angle Interferometer. Metrologie of Gage Blocks. U.S. Department of Commerce, NBS Circular (1957) No. 581, p. 61.

[24] Taylerson, C. O., Testing circular division by means of precision polygons. The Machinist (Ldn) Sep. 13 1947, pp. 623 - 626 und. Engineering, July 23 1949, pp. 73-75.

[25] Taylerson, C. O., Machine Shop Mag. (1947), p. 91.

[26] Thiemer, R., Kunz, M., Automatische Prufung von Prazisionsteilkreisen mit on-line-Rechnereinsatz, Messen-Steuerm-Regeln 22 (1979), pp. 582-588.

Vocabulary for metrologists

THE NEW VIM

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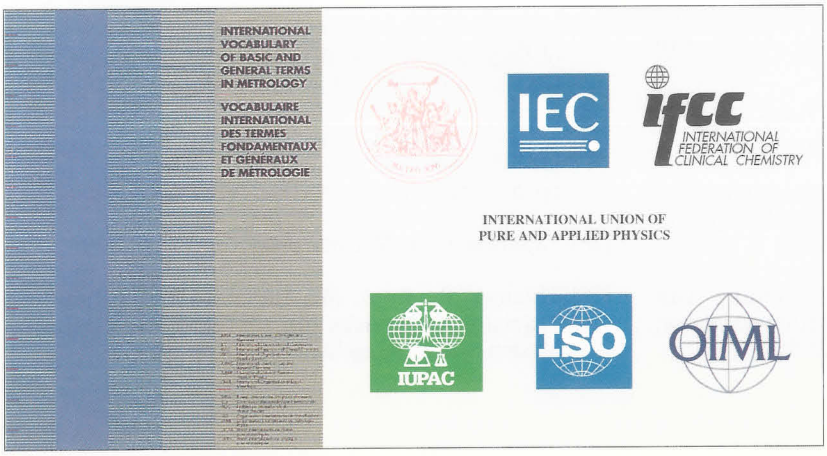


The revision of the "International vocabulary of basic and general terms in metrology" (known generally as the "VIM") was anticipated as long ago as 1984.

When the first edition of the VIM appeared in 1984, it was already foreseen that a revision would be necessary after the passage of ten years or so.

The newly-revised VIM has recently been published, having been produced by a working group of ISO's Technical Advisory Group on Metrology (TAG 4), following an appeal to users of the first edition to send in their comments and suggestions for revision. The group comprised representatives from BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML.

THE NEED FOR CHANGE

There was initially reluctance among some members of the working group to make any changes to the first edition. It was argued that the meanings of metrological terms were timeless and that their definitions had to be stable to be of use to the metrological community; the group should avoid making any change that was not shown by public comment to be absolutely necessary.

In the event every definition was changed to some extent, if only to satisfy an ISO standard for vocabularies that requires that a definition should not begin with an article ("a" or "the"), or in recognition of changing linguistic usages, for example the use of "that" in place of "which" where the sense is restrictive.

Many suggestions and comments were received in response to the appeal, but it became apparent to the working group after several meetings that few users of the VIM had given its contents as much detailed and prolonged thought as the members of the group themselves; or so it seemed to them!

It was taken as an axiom, which the OIML representative strongly supported, that no definition should be changed for change's sake or simply to make it more elegant; and that no term in current use in international standards and OIML Recommendations should take on a new meaning, different from that understood at the time that the document concerned was drafted.

The enlargement of the working group in relation to that which drafted the first edition has meant that some terms are given a wider applicability, and examples are drawn from a broader field of metrology.

MODIFIED DEFINITIONS: IMPROVEMENTS IN CLARITY AND PRECISION

On examination some definitions were found to be ambiguous, or obscure, sometimes because of excessive wordiness, and the group felt justified in removing doubts about their meanings or in pruning unneeded verbiage.

An example is the definition of influence quantity. In the first edition it was defined as:

A quantity which is not the subject of measurement but which influences the value of the measurand or the indication of the measuring instrument. Examples: ambient temperature; frequency of an alternating measured voltage.

In the new edition it is defined:

quantity that is not the measurand but that affects the result of the measurement.

Examples: temperature of a micrometer used to measure length; frequency in the measurement of the amplitude of an alternating electric potential difference; bilirubin concentration in the measurement of haemoglobin concentration in a sample of human blood plasma.

The definition should be read with that of **measurand,** now defined as:

particular quantity subject to measurement.

Example: vapour pressure of a given sample of water at 20 °C. Note: the specification of a measurand may require statements about quantities such as time, temperature and pressure.

The omission of the words 'the value of the measurand' from the old definition of **influence quantity** is in recognition of the unchangeability of the measurand, the quantity specified as that to be measured. Additional remarks about the examples of **measurand** and **influence quantity,** and about the definitions themselves are presented in another article entitled "Personal reflections about the VIM". (*See* pp. 35–37)

DEFINITIONS AT VARIANCE WITH UNIVERSALLY ACCEPTED MEANINGS

Some definitions were found not to represent correctly the meanings universally attached to the terms to which they were applied, because some circumstance had been overlooked. For example **discrimination threshold** is defined in the first edition thus:

The smallest change in a stimulus which produces a perceptible change in the response of a measuring instrument.

Note: the discrimination threshold may depend on, for example, noise (internal or external), friction, damping, inertia, quantization. Example: if the smallest change in load which produces a perceptible displacement of a pointer of a balance is 90 mg, then the discrimination threshold of the balance is 90 mg.

The new edition describes it:

largest change in a stimulus that produces no detectable change in the response of a measuring instrument, the change in the stimulus taking place slowly and monotonically.

Note: the discrimination threshold may depend on, for example, noise (internal or external) or friction. It may also depend on the value of the stimulus.

This striking change in the definition arises from the realisation that the smallest change in the stimulus to change the response is the last infinitesimally small change of stimulus just before the response changes. But the discrimination, as metrologists everywhere understand it, is the largest additional change in stimulus, in the same direction as before, that can take place without provoking a further change in the response.

Similarly, **dead band** was formerly defined:

The range through which a stimulus may be varied without producing a change in the response of a measuring instrument.

It now reads:

maximum interval through which a stimulus may be changed in both directions without producing a change in the response of a measuring instrument.

Thus it makes clear that **dead band** is commonly twice the magnitude of the **discrimination** of the instrument, because in determining the dead band the change of the stimulus must take place in both directions, not monotonically. This definition also avoids the use of the word **range,** whose meaning varies as between statisticians and metrologists, though in the VIM it consistently means a set of values whose bounds are specified.

CHANGES OF PHILOSOPHY

Some of the new definitions reflect changes in metrological philosophy that have continued to take place and find acceptance in the years since the drafting of the first edition. They centre on the notions of **true value, error,** and **uncertainty.**

The first two of those terms are, of course, linked, if **error** is defined as:

result of measurement minus a true value of the measurand.

It can be argued that neither is a metrological term, because metrology is the (necessarily inexact) science of measurement and can never aspire to a knowledge of a true value; it makes a best estimate of a value of the measurand, but it has no means of knowing how nearly that estimate approaches an ideal 'true' value.

The term is not used by metrologists as they go about their work; it is met in committees drafting vocabularies and standards, and in instructional manuals on measurement! Nevertheless the working group thought that it would be too radical a step to omit the term from the second edition of the VIM; that might be the task of the group's successors considering a later version.

The group felt, however, that it had to take account of the realization that the specification of a measurand is rarely such that it can admit of only one value that is compatible with it. It would require an infinite amount of information to define a quantity with a unique value, with the possible exception of certain 'constants of nature'; indeed some quantities (for example in biochemistry) can be characterized only by the parameters of a dispersion of values.

True value (of a quantity) is now defined:

value consistent with the definition of a given particular quantity.

Notes: 1) This is a value that would be obtained by a perfect measurement. 2) True values are by nature indeterminate. 3) The indefinite article "a", rather than the definite article "the", is used in conjunction with "true value" because there may be many values consistent with the definition of a given quantity.

In conformity with the above, **error (of measurement)** is defined:

result of a measurement minus a true value of the measurand, with a note to say that in practice 'errors' are determined in relation to a **conventional true value.**

The impossibility of knowing the closeness of a result of measurement to a 'true' value is also reflected in the new definition of **uncertainty.** That term is constantly used by metrologists; not only do they acknowledge it as a useful concept, but they evaluate it in probabilistic terms, characterising it by a parameter familiar to statisticians.

However, there was a divergence in the past between what they defined as the concept and what the statistical parameter represents. The first was defined in the first edition of the VIM as:

An estimate characterizing the range of values within which the true value of a measurand lies, with a note to say:

"Uncertainty of measurement comprises, in general, many components. Some of these components may be estimated on the basis of the statistical distribution of the results of series of measurements and can be characterized by experimental standard deviations. Estimates of other components can only be based on experience or other information."

That note shows the nature of the divergence, for none of the information mentioned (even "other information") bears any known relationship to a true value, so it cannot be said to lead to an estimate characterizing a range of values embracing 'the' true value.

The new definition of **uncertainty of measurement** is that adopted in the *Guide to the expression of uncertainty in measurement.* It reads:

parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand.

Note 1: the parameter may be, for example, a standard deviation (or a given multiple of it), or the half-width of an interval having a stated level of confidence.

That is a difficult definition to understand for anyone unaccustomed to thinking in those terms; it is accompanied in the VIM by a further fifteen lines of notes, too numerous to reproduce here. It describes what is actually attempted when a metrologist estimates the uncertainty of his result.

It is true that he would very much *like* to be able to obtain an estimate of the likelihood of the result's being at the centre of some specified interval embracing a true value, but in reality he can refer only to measured values, whether directly by his own observations or indirectly by those of others, or from information derived from other observations. None of the results of those observations includes, to anyone's knowledge, a true value. The new definition has no new effect on the practice of measurement or on the estimation of uncertainty; but it states more correctly than has been stated in the past what such an estimate represents.

It must be borne in mind that the VIM is for the use of metrologists of every kind, not only legal metrologists. Someone who calibrates length standards used in manufacturing industry may feel that the traceability of his reference standard to a national standard is sufficient assurance, for his purposes, that a 'true value' of his reference standard lies within the stated range, with the given level of confidence.

An astronomer measuring the distance from earth of a distant galaxy (also a length measurement) would be profoundly disinclined to make statements about the probable nearness of his result to a 'true' value: he is too aware of the nature of the assumptions on which his method of measurement is based. There have been many examples of improved methods of measurement giving results wildly outside the limits of uncertainty formerly attached to the value of a particular measurand.

NEW TERMS FOR NEW CONCEPTS

A few new terms have been introduced, some of them ultimately (it is hoped) to replace existing terms having the same definition. In the latter case both the new and the old are given, having equal validity; but the newer term is presented first in the hope that in the course of time it will supplant the older one. Examples are:

displaying (measuring) instrument

indicating (measuring) instrument

displaying device
indicating device

analogue measuring instrument
analogue indicating instrument.

In each of those cases the word 'indicating' has been eliminated in the new term, and the word 'displaying' has been introduced. The purpose is to clear up an inconsistency in the use of the words 'indication' and 'indicating' that occurred in the first edition, and to make a clear distinction between an instrument or device that 'displays' a number or value visually, and one that merely 'records' it, possibly in a magnetic medium.

Another such example is:

conventional reference scale
reference-value scale

for particular quantities of a given kind, an ordered set of values, continuous or discrete, defined by convention as a reference for arranging quantities of that kind in order of magnitude [the words underlined are new].

The use of the term **value** here has meant a slight revision of the definition of that term, to broaden it to be applicable also to quantities whose 'values' cannot be used algebraically.

Some members of the working group wanted to preserve the original, restricted meaning of **value** (product of a number and a unit of measurement), but it was decided that the term was so widely used and accepted with reference to quantities like pH and hardness that such a restriction was not possible.

Other new terms are:

range of indication – *set of values bounded by the extreme indications.*

This term displaces **scale range** to provide one that is equally applicable to analogue and digital measuring instruments.

deviation – *value minus its reference value.*

This term is much used in legal metrology. By 'its' is surely meant 'a relevant', but I cannot remember why we did not use those words!

TERMS IN THE FIRST EDITION THAT ARE NOT RETAINED

A number of terms that were defined in the first edition have been omitted from the new edition, for various reasons.

The main group of such terms are those that try to characterise various methods of measurement, such as 'direct', 'indirect', 'fundamental', 'definitive', 'direct-comparison', 'substitution', 'differential' and 'null'. One can think of countless examples of actual methods of measurement, each of which could be described equally well by more than one of those terms.

That is not to say that the terms cannot usefully be employed, but it is neither possible to give them mutually exclusive definitions nor to use them without some amplification. The working group concluded that the general meanings of the qualifying words were those given in dictionaries (except 'definitive', which was misused in the first edition), and that they must be understood in their contexts.

Another term that was omitted after much debate was **measure-**

ment process. It was felt that, with **method of measurement** and **measurement procedure** already defined, the words in 'measurement process' should be allowed their dictionary meanings, amplified and made clear by the context in which they are used.

The terms **static measurement** and **dynamic measurement** have been omitted because their definitions were not consistent with the concepts of **(measurable) quantity** and **measurand;** values that differ with time apply to different quantities, not to a 'varying' quantity. Others were omitted because their use in metrology did not give them meanings that were distinctive from those generally understood, for example **recording medium.**

NON-NOMINAL PARTS OF SPEECH

In an explanatory note it is pointed out that all the terms defined are nouns. However, users of the VIM are urged to make free use of other parts of speech, notably verbs, that bear a clear relationship to the nouns that are defined. For example, although the verb 'to measure' is not defined, it is clearly the one from which the noun measurement is derived; it should be used in preference to 'to effect a measurement'. In the same way it is not necessary to say that 'a correction was applied' to a result; rather it should be said that the result 'was corrected'. ■

REFERENCES

International Vocabulary of Basic and General Terms in Metrology. Second edition 1993. ISBN 92-67-01075-1. International Organization for Standardization.

Guide to the Expression of Uncertainty in Measurement. First edition 1993. ISBN 92-67-10188-9. International Organization for Standardization.

Viewpoint

PERSONAL REFLECTIONS ABOUT THE VIM

W. H. Emerson, former Ingénieur Consultant, Bureau International de Métrologie Légale

The revision of the VIM has not been a root-and-branch exercise, re-examining its purpose, looking again at its whole structure; it has been more a tidying and perfecting of an existing structure. It is a significant improvement on the first edition and can be commended with confidence to all practitioners of the metrological arts.

The occasion of the next revision will probably be the time to consider more radical changes, and they will surely be needed. The VIM is still slightly redolent of solid-brass instruments in polished mahogany cases; it defines twelve different terms for the parts and attributes of dials, scales and pointers, and none for digital displays. It clings, but less tightly now, to mid-twentieth-century ideas of 'true value', which twenty-first-century metrologists will not look upon as a metrological term.

__W. H. Emerson__ was employed at the National Engineering Laboratory at East Kilbride, Scotland from 1960 to 1987 and specialized in heat transfer before moving on to more administrative duties, notably in energy conservation. During that time he also served as the UK's representative on the OIML Secretariat for Heat Meters. In 1987 he joined the staff of BIML as Consultant Engineer, retiring in 1992.

TERMS MERITING FURTHER CONSIDERATION

However, there is still some tidying and perfecting to be done. One of the principles of a vocabulary is that a term that has been defined should not undergo a change of meaning when it is included in another term. In the VIM the term **error** is defined; but its defined meaning is incompatible with the terms **random error** and **systematic error,** as *they* are defined.

The result of a measurement of a measurand having a single true value (for example of a constant of nature) has an error. However that error may be described, there is only one of it: the definition allows only one; other quantities associated with the result cannot also be simultaneously described as errors, with qualifying adjectives such as 'systematic' or 'random'.

One solution might be to retain, at the next revision, the term **error** used alone to mean a **deviation** in relation to a conventional value, and to change **systematic error** to **systematic deviation,** in relation to the same conventional value. The term **random error** can be abandoned without loss: it is indeterminate. Whether or not all of that can be done will depend on the authority and persuasiveness of the VIM and its revisers at that time.

REPEATABILITY AND REPRODUCIBILITY

The terms **repeatability of results of measurement, repeatability of a measuring instrument** and **reproducibility of results of measurements** are all given very similar definitions in the VIM. In fact the repeatability of a measuring instrument could be much more briefly defined as 'the ability of a measuring instrument to give repeatable results of measurement'.

But the first term, **repeatability of results of measurement,** as defined, is really an attempt to define the parameter, normally a standard deviation, that characterises the probability distribution function of the deviation from the expectation of a result of measurement. The term, as it appears and as it is described, does not suggest that. What should be sought is a term to be applied to the contribution to the uncertainty of the result of measurement arising from the random departure of the result from the expectation value. It should have an appropriate name and definition and the term 'repeatability of results of measurement' should be abandoned.

The differences between the definitions of **repeatability** and **reproducibility,** for the same instrument, method, observer, place and conditions of measurement, reduce only to a difference of time. According to the VIM, if the period of observations is short, the correct term is then 'repeatability'; if the period is long, the term is 'reproducibility'. Here 'short' presumably means as short as possible - the shortest time in which a statistically adequate number of observations can be made. (See my remarks above about the real, useful meaning.)

But there are many measurements that are made periodically to observe trends, and the user, using the same instrument, expects the result to be repeatable. For example, someone watching his weight expects his bathroom scales to indicate the same weight at the beginning and end of a month if his weight has not changed in that time; that is the way in which such instruments are used. He expects the result to be 'repeatable'. (If he weighs himself on another instrument, he hopes that the result is 'reproducible'.)

In other words, repeatability is not necessarily, or indeed ordinarily, a short-term phenomenon; users expect instruments to be repeatable over a useful period, which may be many months. It is an aspect of **stability.**

But why, indeed, should random effects always be considered short-term? The factors affecting results of measurements can be Brownian motions, mechanical vibrations, diurnal effects, lunar gravity, solar activity, climatic cycles, the precession of the equinoxes, any of which may be sampled randomly. The list may seem far-fetched, but exposes the arbitrary ways in which "short period" can be interpreted.

The VIM's definition of **reproducibility** allows only one of the list of variable conditions to be varied; but is that consistent with metrologists' normal use of the term?

When a scientist announces a startling result of an experimental measurement, other scientists throughout the world immediately try to 'reproduce' the measurement, to see whether it is indeed reproducible. They do so by realizing *ab initio,* in their own laboratories, the procedure adopted in the measurement first announced, or even another procedure that scientists would agree was of equal validity to accomplish the measurement. Simply substituting another instrument in the first scientist's laboratory, or bringing in a different technician to do the work, would not be regarded as reproducing the measurement.

CHARACTERIZING CONVENTIONAL REFERENCE SCALES

The working group has still not found a satisfactory definition of **conventional reference scale.** The group rejected the inclusion of the International Scale of Temperature as an example, because it so nearly represents the thermodynamic scale, values of which can be manipulated algebraically. But even if a practical scale of temperature was not deliberately made similar to the thermodynamic scale, it would not be used merely to rank temperatures in order of magnitude.

For example the ratio of heat flux to temperature gradient (that is, thermal conductivity) in a particular medium would still be a (admittedly less) useful concept if a more 'practical' temperature scale were used in place of the thermodynamic scale. Likewise a fuel's octane number is measured to determine the fuel's fitness for a given type of engine, not to "arrange [octane numbers] in order of magnitude". It is even possible to envisage the ratio of the change of minimum necessary octane number to the change of compression ratio, as a useful concept.

TWO BASIC TERMS

The VIM still has weak definitions of two of its most basic terms: **measurement** and **measurand.** The first is defined: *set of operations having the object of* *determining the value of a quantity.* It says nothing about the nature of those operations, that they require the physical application of physical laws in a controlled manner, generally by the comparison, directly or indirectly, of a particular quantity with a unit of that general quantity. The mere act of consulting a reference book of physical constants would satisfy the VIM's definition of measurement. Fortunately though, few people are likely to consult the VIM to find out what 'measurement' is!

The weakness of the definition of **measurand** is more serious, and is shown by an inconsistency in its use in the VIM itself. The definition of **influence quantity** was changed from that of the first edition, because the measurand itself (the quantity specified as that whose value is sought), and therefore its value, could not be changed by an influence quantity. But **transparency** is defined: *ability of a measuring instrument not to alter the measurand;* and an example is given of an instrument that is *not* transparent: a resistance thermometer that heats the medium whose temperature it is intended to measure.

The quantity that is the measurand is normally specified independently of the instrument by which it may be measured; it is frequently not identical to the quantity that is realized and to which the measurement procedure is applied. In the example the measurand is the temperature of the medium without the presence of a thermometer (otherwise the concept of transparency does not arise); the quantity realized is of the medium in the presence of the thermometer. Thus the uncorrected result must be corrected to compensate for the heating effect of the thermometer. The VIM has here confused **measurand** with 'realized quantity'. The confusion might not have arisen if a term **quantity realized for a measurement** had been defined.

The definition of **measurand** should make it clear that it is the quantity that is specified to be, or to have been, measured, the quantity whose value is required or is reported, regardless of the quantity to which instruments may be, or have been, applied. But there is another aspect of the definition that has relevance to the definition of **influence quantity.**

The example of a measurand given is 'vapour pressure of a given sample of water at 20 °C. But rarely is anyone interested in the vapour pressure at exactly 20 °C, and no one would go to the trouble of constructing an apparatus for a measurement at a single temperature; he would vary the temperature to obtain the saturation curve of pressure and temperature over a specified range, which might be expressed in terms of either pressure or temperature.

For each point on that curve there would be two measurands: temperature and pressure, of equal importance, and neither of which is an **influence quantity.** A measurand can be multidimensional. In the examples given of influence quantities, none is of a quantity that contributes to the definition of the measurand; though with many measurands, for example the length of a particular gauge at 20 °C, the deviation of a defining quantity (in this case the temperature of the gauge) from the specified value has the nature of an influence quantity.

The OIML representative tried to obtain from the working group a term that meant simultaneously what is now called **scale interval** for an analogue measuring instrument, and **resolution** for digital instrument: a term much needed in legal metrology. The group thought that that was a matter for legal metrologists, not one for a vocabulary of basic and general terms in metrology. Suggestions, please, to the Editors of the Bulletin.

ACKNOWLEDGEMENT

The above reflections are indeed my own, and do not necessarily reflect the views of ISO/TAG 4, BIPM or BIML. They have, however, been influenced by a very enjoyable discussion with Pierre Giacomo, Emeritus Director of BIPM. ■

Editorial note: An article on the *Guide to the Expression of Uncertainty in Measurement* by W. H. Emerson will be published in the next issue of the OIML Bulletin, Volume XXXV, Number 3, July 1994.

Metrology in the Czech Republic

IMPLICATIONS OF A NEW POLITICAL AND ECONOMICAL ORDER

DR P. KLENOVSKÝ, DR F. JELÍNEK, V. GÁBA*, Czech Metrological Institute

THE Czech Republic is situated in the heart of Europe. It has four neighbors: Germany, Poland, Slovak Republic and Austria. The country covers an area of 78 864 km^2 and has a population of approximately 10.4 million.

Prague, (*Praha* in Czech), the capital (pop. 1.3 million) of the Czech Republic, is the industrial and cultural center of the country. It is a city with countless historical monuments, nice architecture, beautiful surroundings and eventful modern life.

However, there is much more to the Czech Republic than the capital. The lands of Bohemia, Moravia, and Silesia offer beautiful landscapes, and historical cities as well as a modern industrial infrastructure. The second largest city is Brno (pop. 380 000), which lies at the center of Moravia and which has an important concentration of state administrative, commercial, and industrial activities.

The Czech Republic was constituted on 1 January 1993 after the division of Czechoslovakia. It consists of so-called Czech States which follow closely the traditions of previous Czechoslovakia in which they have played a significant role.

Prague, capital of the Czech Republic.

After the collapse of the communist regime in 1989, Czechoslovakia embarked on a radical economic and social transformation aimed at establishing a healthy market economy and standard European democratic political system. In both of these spheres the country has been successful and the Czech Republic continues all positive developments.

BASIC CONCEPTS AND NEW METROLOGICAL DEVELOPMENTS IN THE CZECH REPUBLIC

The recent changes in political and economical conditions are reflected in the new metrology infrastructure. Metrology in the Czech Republic falls under the responsibilities of the Ministry of Economy.

MINISTRY OF ECONOMY FOR THE CZECH REPUBLIC

Among other tasks, the Ministry of Economy supervises the governmental policy in the field of metrology, prepares the concepts for metrological development and exercises control over the Czech Office for Standards, Metrology and Testing (COSMT), the Czech Metrological Institute (CMI) and the Czech Accreditation Institute (CAI).

* Dr. Pavel Klenovský, CMI Director Brno; Dr. František Jelínek, Deputy Director, R&D, Prague; Mr Vojtěch Gába, Secretary for International Affairs, Brno.

CZECH OFFICE FOR STANDARDS, METROLOGY AND TESTING

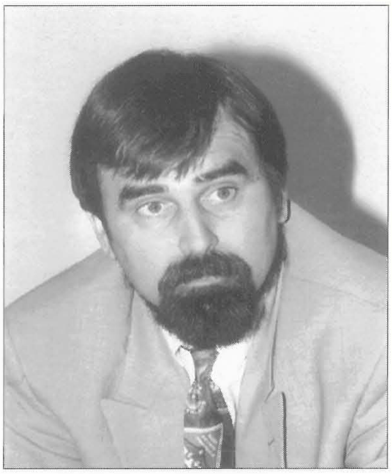
In the field of metrology, this body supervises the activities of state metrology bodies and authorizes organizations to carry out legal metrology activities. COSMT also determines which measuring instruments are subject to mandatory verification and approves official Czech metrological regulations (i.e. methodical instructions for metrology and technical metrological directives).

Czech national standards and reference materials are approved and declared by COSMT which also makes decisions concerning the recognition of pattern approvals, and verification of measuring instruments.

CZECH ACCREDITATION INSTITUTE (CAI)

The CAI is responsible for building up and implementing the Czech accreditation system based on European Standards, series EN 45 000 and represents the Czech Republic in international organizations with corresponding activities.

In addition to performing the accreditation of testing and calibration laboratories, CAI grants, withdraws or amends certificates of accreditation and decides as to their suspension or withholding. Registers of applicants for accreditation are kept by CAI as well as those for accredited bodies and other documentation related to accreditation.



Dr Pavel Klenovský, Director of the Czech Metrology Institute.

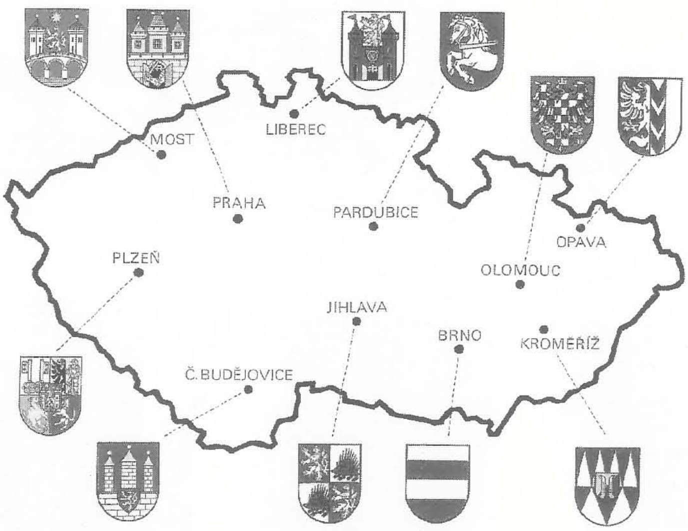
The CAI prepares, publicizes and distributes regulations (methodical instructions, methodical manuals etc.) within the scope of its activities and participates in the preparation of legal regulations. Other activities include:

- the authorization of corporate bodies to act as accreditation centers and the coordination and inspection of their activities;
- the establishment of qualification requirements for assessors and the staff of laboratories and participation in their training;
- the permanent inspection of continuous compliance of the accredited bodies with accreditation criteria.

CZECH METROLOGICAL INSTITUTE (CMI)

According to the statute of the CMI, its main objectives are to act as a national authority in the field of Czech national and primary standards of physical and technical units and their scales and to maintain and develop the above-mentioned standards, including their international traceability. It is also the CMI's responsibility to disseminate these units to subsequent lower metrological orders.

Other general tasks of CMI include carrying out research and development in the field of metrology, supervising the preparation of reference materials and their certification, and preparing and promoting metrological standards and procedures which concern the



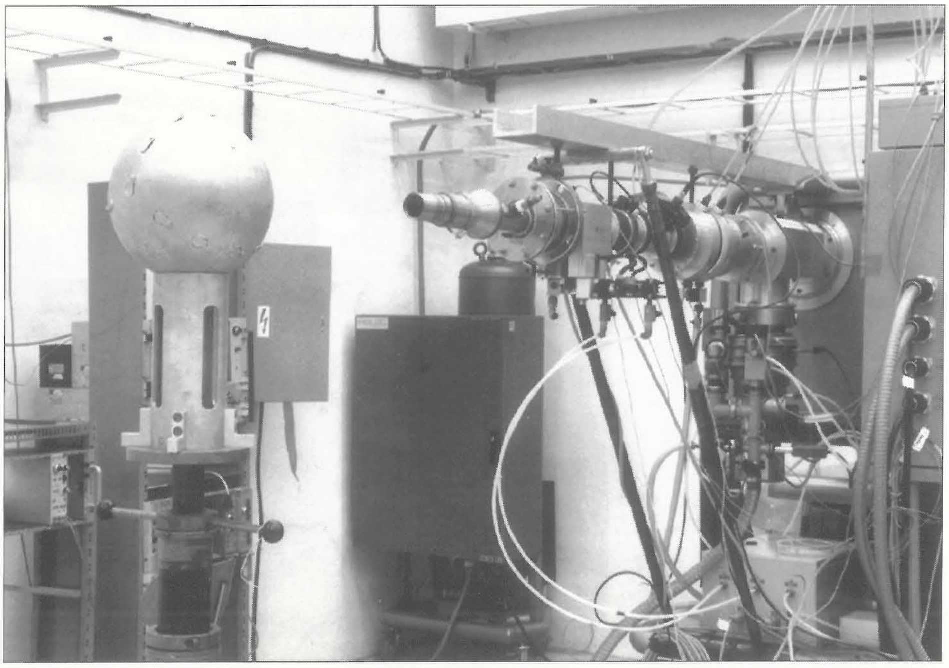
Map of the Czech Republic with CMI branches dissemination of units from national to secondary standards, verification of legal metrology instruments, various calibration methodologies, etc.

It is also the responsibility of CMI to supervise and organize participation of the Czech Republic in international cooperation in the fields of scientific and legal metrology and in the field of reference materials.

Additional tasks of the CMI include the following:

- drafting decrees on legal metrology instruments
- taking part in secondary metrology of physical and technical units to maintain and develop its internal standards and to develop calibration procedures
- carrying out state metrological control of measuring instruments of individual and corporate bodies, to function as one of the laboratories of the national calibration service
- performing state metrological inspections of individual and corporate bodies (including authorized metrological laboratories) aimed at their compliance with metrological controls
- carrying out official registration of manufacturers and repairers of measuring instruments
- participating in product certification and certification of quality control systems, especially from the viewpoint of metrology
- offering metrological analyses, assessments and information with a veiw to organizing specialized metrological courses
- repairing, manufacturing, and assembling measuring instruments on a limited scale given its technical capabilities and the lack of these services on the local market
- operating a system of scientific and technical information concerning metrology
- providing consultant services for Czech metrological laboratories
- carrying out the sale and purchase of measuring instruments, equipment and material to support its activities. For this purpose, CMI implements non-profit imports and exports of measuring instruments and equipm3ent.
- manufacturing and certifying standard sources of ionizing radiation for calibration purposes and organizing their distribution to customers. For this purpose, CMI implements

A CMI staff member works in the acoustic laboratory. The Czech Republic is a P-Member of OIML TC 13 "Measuring instruments for acoustics and vibration".



CMI neutron generator in the neutron metrology laboratory. The Czech Republic is a P-Member of OIML TC 15 "Measuring instruments for ionizing radiations".

non-profit exports and imports of radioactive materials.

AUTHORIZED METROLOGICAL CENTERS (AMC)

Authorized Metrological Centers are organizations that have been authorized by the COSMT to perform certain metrological activities that are subject to control in the Czech Republic. These organizations must pass an accreditation according to EN 45000 which consists of an independent assessment of their technical capabilities and of the staff qualification levels.

AMCs deal in particular with the state metrological control of measuring instruments and with the maintenance of national standards within the scope of their authorization. COSMT grants (and withdraws if necessary) a special official stamp of verification to every AMC.

BASIC LEGAL METROLOGY DOCUMENTS IN THE CZECH REPUBLIC

- Law No. 505/1990 on metrology effective 1 February 1991-prepared in compliance with OIML Document No. 1 (model Law on metrology).
- Law No. 20/1993 on implementation of the state administration in the field of standardization, metrology and testing and issued by the Czech National Council.
- Decree No. 69/1991 issued by the Federal Office for Standardization and Measurement, effective 31 January 1991 - foundation for the practical implementation of the law on metrology.
- Decree No. 231/1992 issued by the Ministry of Economy - amends the Decree No. 69/1991.
- Ordinance No. M-102/93 on legal metrology instruments issued by the Czech Office for Standards, Metrology and Testing (19 October 1993).

LEGAL METROLOGY INSTRUMENTS

Legal metrology instruments are those instruments which fall under state metrological control as imposed by the COSMT and which were ordered by the latter to be subject to mandatory verification due to their significance for the protection of fair trade, public health, environment, safety at work and other public interests.

A list of the types of instruments concerned by legal metrology has been published in the COSMT official journal together with the corresponding recalibration intervals. The list is published as an ordinance on legal metrology instruments.

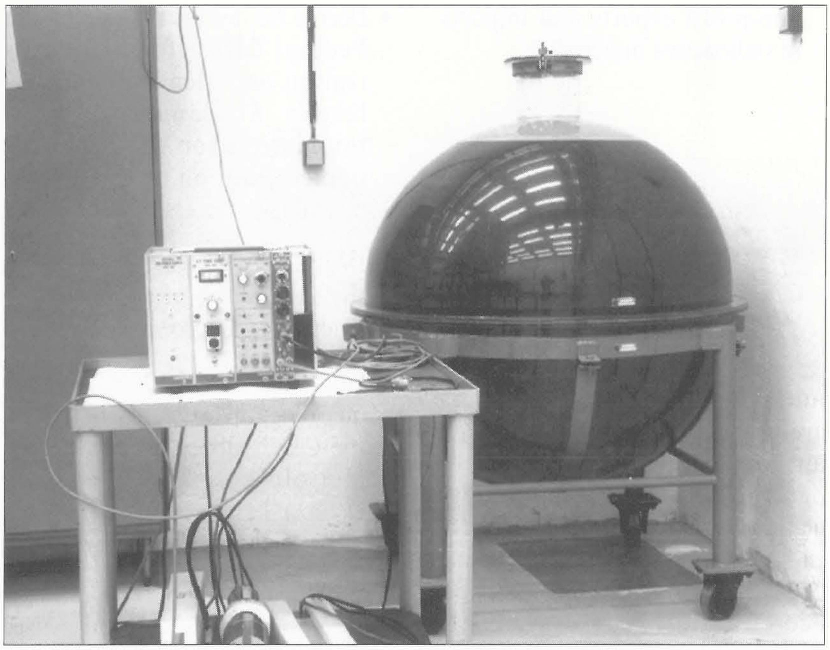
CALIBRATION SERVICES

In the Czech Republic, calibration services are performed by organizations for their purposes by means of their own standards that are calibrated by CMI, authorized metrological centers (AMC), CMI laboratories, or by accredited calibration laboratories - i.e., by organizations that have been accredited after their application to render metrological services to other organizations.

Calibration in the Electricity Department, CMI laboratory.

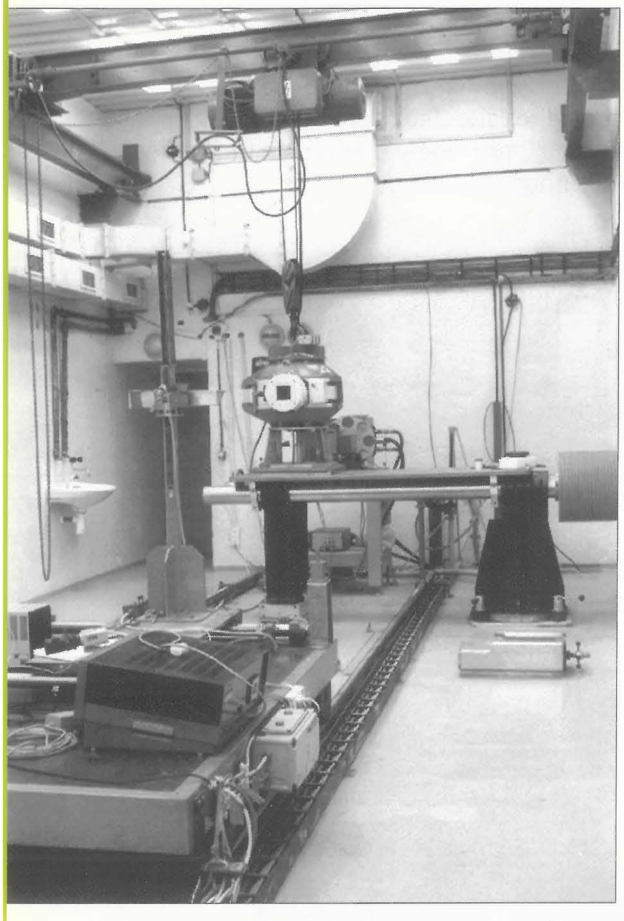
PRIMARY AND NATIONAL STANDARDS, HIERARCHY SCHEMES

National metrology in the Czech Republic follows the tradition of the metrological system that was implemented in the former Czechoslovakia. To overcome some problems that Czech metrology has encountered due to the separation from Slovakia, a system is foreseen that will take advantage of all national resources and experience. This includes experience to be found at the high level of university and research laboratories as well as in industry.



Manganese sulphate bath, CMI laboratory.

Due to a relatively favorable situation in the existing infrastructure of secondary metrology and to the fact that primary and national standards are available in the most important fields, a proportional development in all the parts of the hierarchy schemes can be envisaged.



Secondary standard beam for calibrating dosimetric instruments.

High level metrology services will be provided by:

Czech Metrological Institute:
for a majority of primary and national standards and of secondary standards of the highest orders (all the basic units except for time and luminous intensity, many derived units, units of ionizing radiation).

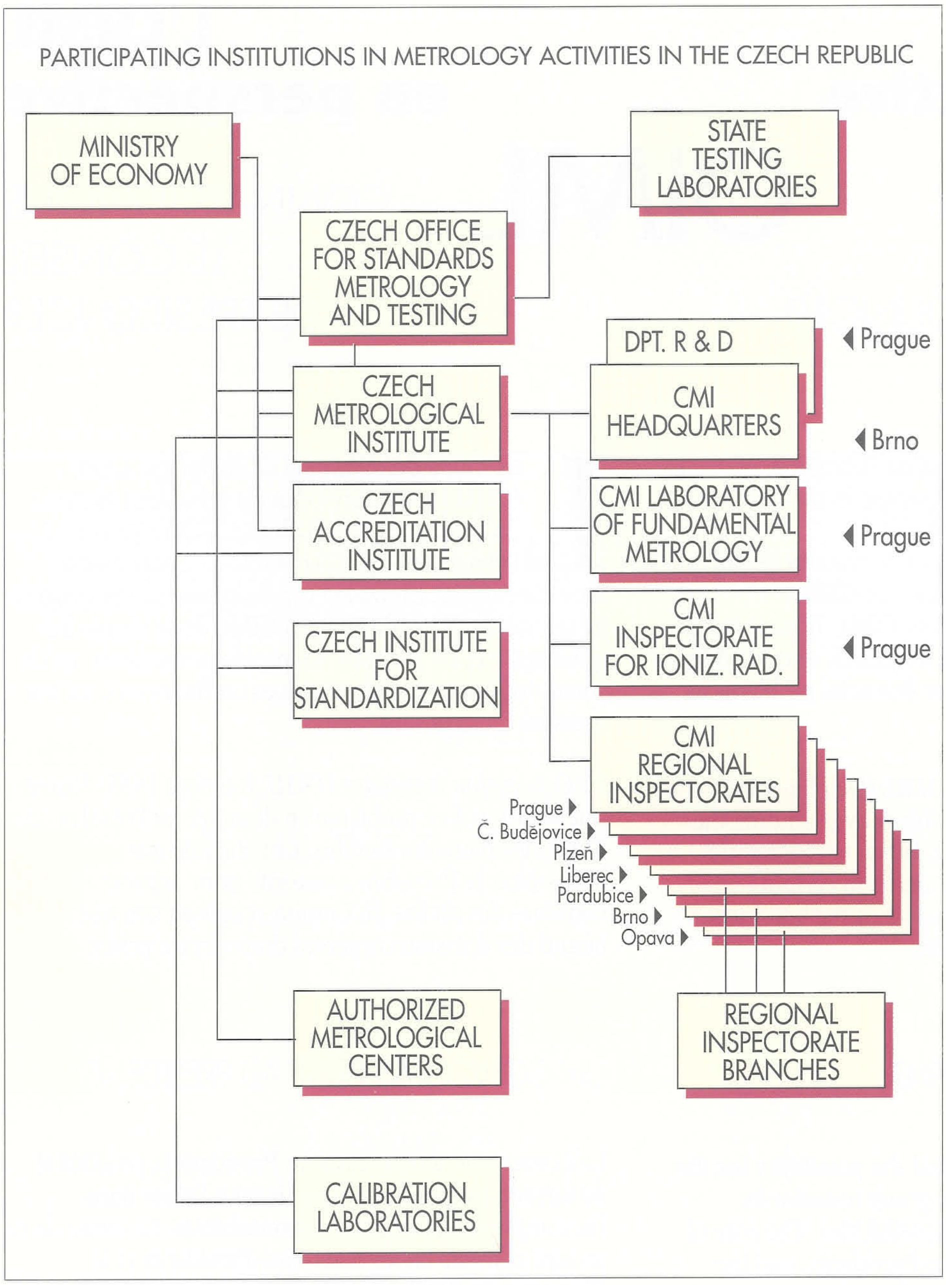
Selected authorized metrological centers:
for some groups of quantities with special fields of application or when the number of required calibrations is relatively small and when the calibration orientation is predominated.

Metrological institutions from abroad:
for quantities or their extreme values when it is not reasonable to build up local national metrology due to economic or other practical reasons. In such cases the process of obtaining traceability is coordinated by CMI.

Due to a dynamic development of Czech metrology in connection with the strengthening of the national economy and relations with developed countries, many changes in the structure and quality of the primary and national standards are to be expected in the near future.

THE INTERNATIONAL RELATIONS OF CZECH STANDARDIZATION, METROLOGY AND TESTING

The Czech Republic has maintained the memberships of former Czechoslovakia in many international organizations, governmental and/or non-governmental, that are active in the fields of standardization, metrology, and testing.



As for metrology the Czech Republic is a member of CGPM and OIML. Dr. Klenovský, Director of the CMI, has been appointed to represent the Czech Republic in CIML.

Close professional contacts have been established with BIPM, PTB, NPL, NMi and other metrological institutions. The activities of the Czech Accreditation Institute (CAI) (which are coordinated with those of the CMI) are connected with those of the WECC. ■

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A BRIEF HISTORY OF METROLOGY IN THE CZECH STATE

1268 Ordinance of King Pemysl Otakar II to restore weights and measures referred to as "royal measures"

1358 Emperor Karel IV - an amendment to measures, statewide extension of the "Prague measures"

1541 The Czech Chronicle - contains a surveying document on the measurements

1549 Decree passed by the State Assembly: unification of length, volume and mass measures, introduction of sanctions

1614 A repeated resolution of the Assembly on the uniformity of measuring units

1617 "A book on Provincial measures" by Simon Podolsky

1644 An imperial patent summarizing and repeating the former legislature (Czech countries were under the empire)

1765 Austrian weights and measures introduced by an imperial patent

1872 Law No. 16/1872 of the Imperial Code introducing a new order (amended in 1876, 1884, 1893)

1875 The Austrian Empire joined the Metric Convention

1918 Czechoslovak Central Inspectorate for Metrology Service established (independent Czechoslovakia was established)

1922 Czechoslovakia signed the Metric Convention

1955 State Office for Weights and Measures established

1963 Czechoslovak Standard CSN 01 1300 "Legal units of measurement"

1966 Metrological Institute in Prague established

1968 Czechoslovak Metrological Institute in Bratislava with a branch office in Prague constituted

1980 SI system of units introduced as of 1 January for mandatory use

1990 Law No. 505/1990 on metrology

1991 State Metrological Inspectorate (SMI) established

1993 Law No. 20/1993 on state administration in the field of standardization, metrology, and testing in the Czech Republic

1993 Czech Office for Standards, Metrology, and Testing set up in Prague

1993 Czech Metrological Institute established

OIML in perspective

L'OIML en perspective

DO YOU KNOW ABOUT THE PRESIDENTIAL COUNCIL?

CONNAISSEZ-VOUS LE CONSEIL DE PRESIDENCE?

The *Comité International de Métrologie Légale (CIML)* was presented in the last issue of the OIML Bulletin (Volume XXXV, Number 1, January 1994, p. 32) as the "steering committee" of OIML. Due to the structure and tasks of CIML, however, it is difficult for this body to meet frequently and to address urgent technical, diplomatic or financial problems as they arise.

The *Convention Establishing OIML* (October 1955) provided a solution to this problem by extending the powers of the CIML President. When necessary, the President has the authority to perform certain Committee tasks and act on behalf of the latter when urgent decisions must be made.

ASSISTING THE PRESIDENT

The *Convention* also established the possibility for the President to form an advisory group to assist in fulfilling the presidential responsibilities. The core of this group consists of two Vice-Presidents, and the Director of BIML who serves as Secretary.

With a view to broadening the participation of this advisory group, a *Presidential Council of CIML* has existed throughout the history of OIML. In addition to the two Vice-Presidents, the Presidential Council is composed of CIML Members who are appointed by the President. The number of appointments varies at the President's discretion.

The Members of the Council contribute their experience and expertise through discussions aimed at resolving important issues for the future of OIML. The Director of BIML also participates in the Council and is assisted by the technical agents of the Bureau for all secretarial tasks.

Le *Comité International de Métrologie Légale (CIML)* a été décrit dans le précédent numéro du Bulletin OIML (Volume XXXV, Numéro 1, janvier 1994, p. 32) comme le "comité directeur" de l'OIML. En raison cependant de sa structure et de ses tâches, il est difficile au CIML de se réunir fréquemment et de résoudre les problèmes urgents, qu'ils soient techniques, diplomatiques ou financiers, au moment où ils se posent.

La *Convention instituant l'OIML* (octobre 1955) fournit une solution à ce problème en donnant au Président du CIML des pouvoirs étendus. Chaque fois que nécessaire, le Président a autorité pour accomplir certaines des tâches du Comité et agir en son nom quand des décisions urgentes doivent être prises.

UN CONCOURS PRETE AU PRESIDENT

La *Convention* donne aussi au Président la possibilité de former un groupe conseil visant à l'aider dans l'accomplissement de ses responsabilités. Le coeur de ce groupe consiste en les deux Vice-Présidents et le Directeur du BIML qui agit en tant que Secrétaire.

Afin d'élargir la composition de ce groupe, un *Conseil de la Présidence du CIML* a été établi dès les premiers jours de l'OIML. Outre le Président et les deux Vice-Présidents, le Conseil de la Présidence comprend des Membres du CIML choisis par le Président. Leur nombre est à la discrétion du Président.

Les Membres du Conseil apportent leur expérience et leur savoir dans des discussions destinées à résoudre les questions d'importance pour l'avenir de l'OIML. Le Directeur du BIML participe également au Conseil et est aidé par les agents techniques du BIML dans les tâches de secrétariat.

THE SPECIALIZED NATURE OF THE COUNCIL

The Council addresses a vast range of subjects that have impact on the activities and future directions of OIML. For practical reasons, however, the Council has become "specialized" in certain areas.

Technical activities are often addressed by the Council since CIML meetings do not permit detailed studies of such matters. For example, the Council regularly examines progress made in OIML technical committees and subcommittees.

The Council also specializes in work requiring extensive reflection and discussion (e.g. long-term policy). This activity favors a small-group atmosphere rather than that of a 60-person assembly (which is the case for CIML meetings).

Another responsibility of the Council is to keep informed as to the general financial situation of the Organisation and the activities carried out by BIML (certification, publications, OIML Bulletin, activities for developing countries, etc.).

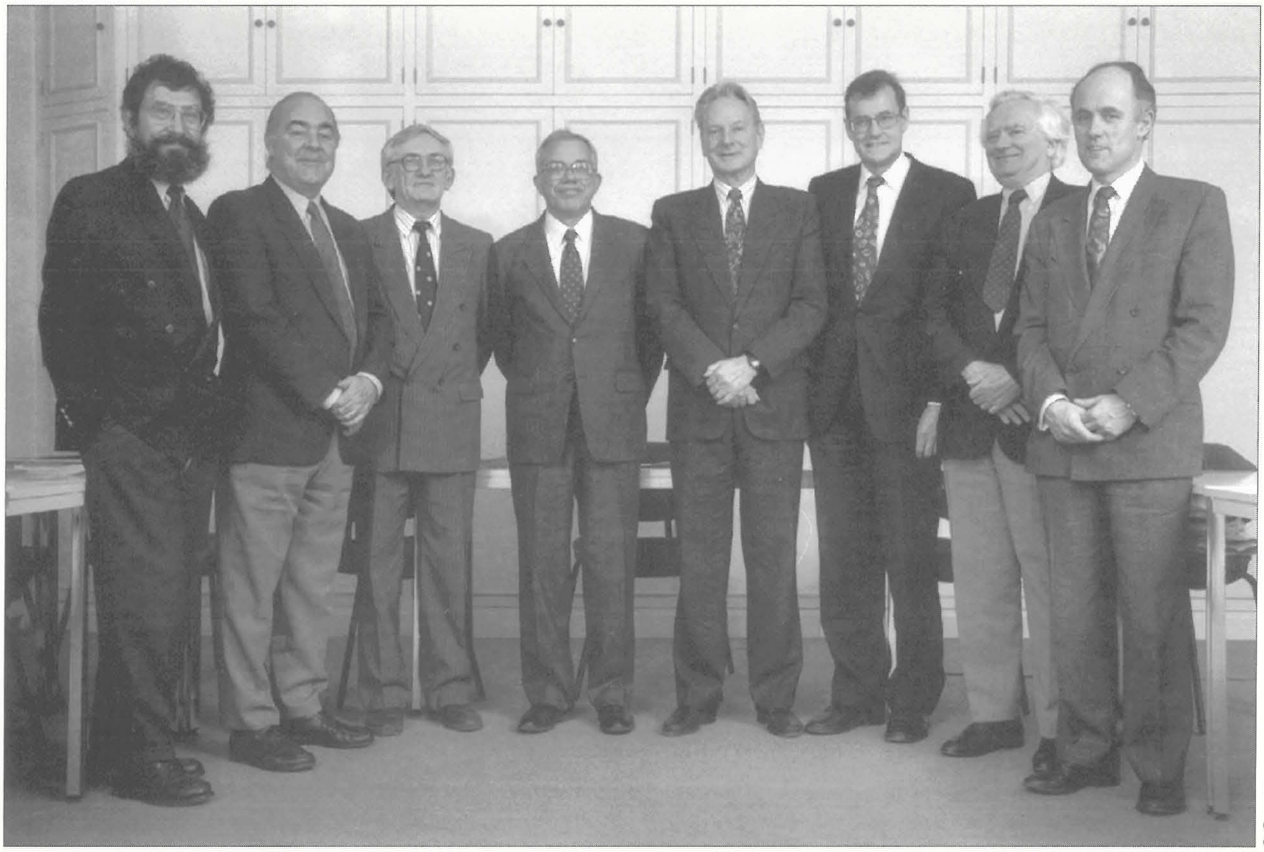
UN CONSEIL SPECIALISE

Le Conseil s'occupe d'un large éventail de sujets importants pour les activités et les futures orientations de l'OIML. Pour des raisons pratiques cependant, le Conseil s'est "spécialisé" dans certains domaines.

Les activités techniques sont souvent examinées par le Conseil car les réunions du CIML ne permettent pas une étude détaillée de ces questions. Le Conseil, par exemple, examine régulièrement les progrès des travaux des comités techniques et sous-comités de l'OIML.

Le Conseil s'est également spécialisé dans les questions demandant d'intenses réflexions et discussions (comme la politique à long terme). Ce genre d'activité est plus favorisé par l'atmosphère d'un petit groupe que par celle d'une assemblée de 60 personnes (comme c'est le cas du CIML).

Une autre responsabilité du Conseil est de prendre connaissance de la situation financière générale de l'Organisation ainsi que des diverses activités du BIML (certification, publications, Bulletin OIML, activités pour les pays en développement, etc.).



F. Osmont

The OIML Presidential Council (from left to right): B. Athané, R. Knapp, L. K. Issaev, S. E. Chappell (Vice-President), K. Birkeland (President), M. Kochsiek (Vice-President), J. Birch, S. Bennett.

THE COUNCIL'S ROLE IS TO COUNSEL

The objective of the Presidential Council is to *advise* the President on various matters and therefore it does not possess a decision-making statute. However, the Council Members do in fact contribute directly to the outcome of important decisions through their participation as CIML Members.

MEETINGS

In general, the Council assembles after the closure of CIML meetings and holds at least one other meeting per year which usually takes place at BIML. Meetings are called by the President whenever there is a need to examine general or specific subjects in detail. The most recent meeting was held at BIML 10–11 February 1994. ■

UN OBJECTIF: CONSEILLER

L'objectif du Conseil est de *conseiller* le Président sur divers sujets, sans avoir statutairement de pouvoir de décision. Cependant les Membres du Conseil contribuent en fait directement à la prise des décisions importantes de par leur position de Membres du CIML.

LES REUNIONS

Le Conseil se réunit en général après la clôture des réunions du CIML et tient au moins une autre réunion dans l'année, le plus souvent au BIML. D'autres réunions sont convoquées par le Président chaque fois qu'un besoin existe d'examiner en détail une question générale ou particulière. La dernière réunion du Conseil s'est tenue au BIML les 10 et 11 février 1994. ■

Consultations

OIML COUNCIL FOCUSES ON KEY TOPICS

The OIML Presidential Council met at BIML in Paris 10-11 February 1994 to address technical, financial, and administrative subjects concerning the Organisation. Particular importance was attributed to discussions aimed at developing the future policy orientations of OIML.

Consultations

LE CONSEIL DE L'OIML TRAITE DES SUJETS CLES

Le Conseil de Présidence de l'OIML s'est réuni au BIML à Paris les 10 et 11 février 1994 afin de traiter des questions techniques, financières et administratives concernant l'Organisation. Une importance particulière a été donnée aux débats sur les développements et orientations de la politique de l'OIML.

OIML PRESIDENTIAL COUNCIL

CIML PRESIDENCY

PRESIDENT
K. Birkeland (Norway)

VICE-PRESIDENTS
S. E. Chappell (USA)
M. Kochsiek (Germany)

COUNCIL MEMBERS
S. Bennett (UK)
J. Birch (Australia)
L. K. Issaev (Russia)
R. Knapp (Canada)

SECRETARY
B. Athané
Director of the BIML

F. Osmont

Presidential Council studies documents during its discussion on the future policies of the Organisation.
Le Conseil de Présidence examine des documents pendant le débat sur la future politique de l'Organisation.

F. Osmont

CIML President K. Birkeland stresses the particular importance of the Council meeting in view of the elaboration of a strategy document addressing OIML objectives and priorities and evokes the need to discuss the upcoming election of a new President. Mr Birkeland was elected for a six-year term as CIML President in 1980 and was re-elected in 1986. In 1992, the Committee decided to extend Mr Birkeland's mandate for an additional two years.

K. Birkeland, Président du CIML, explique l'importance particulière de la réunion du Conseil en vue de l'élaboration d'un document de stratégie qui définira les objectifs et priorités de l'OIML. Il évoque également les besoins de discuter de la prochaine élection d'un nouveau Président. M. Birkeland avait été élu pour une période de six ans comme Président du CIML en 1980 et avait été réélu en 1986. En 1992, le Comité avait décidé de prolonger son mandat pour une durée supplémentaire de deux ans.

F. Osmont

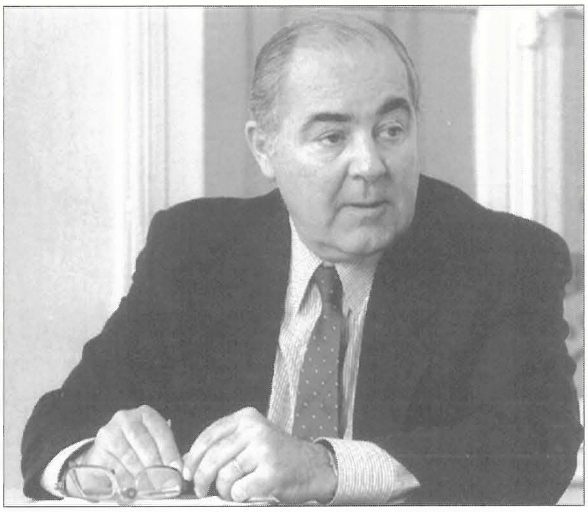
S. E. Chappell, CIML Vice-President, identifies some key aspects to be considered when focusing on OIML and its leadership in the field of legal metrology: broader participation, universal harmonization, mutual recognition of evaluation and test results, and international cooperation.

S. E. Chappell, Vice-Président du CIML, identifie certains points clés pour l'OIML et le maintien de son leadership dans le domaine de la métrologie légale; participation élargie, harmonisation universelle, reconnaissance mutuelle des évaluations et résultats d'essais, et coopération internationale.

F. Osmont

Council member J. Birch and Vice-President M. Kochsiek discuss recent developments concerning the technical activities of OIML. One of the responsibilities of the Council is to reflect on actions to be taken to assure the quality of OIML contributions to international harmonization in the field of legal metrology.

Le membre du Conseil J. Birch et le Vice-Président M. Kochsiek discutent les récents développements relatifs aux activités techniques de l'OIML. Une des responsabilités du Conseil est de réfléchir aux actions à entreprendre pour une meilleure contribution de l'OIML à l'harmonisation internationale dans le domaine de la métrologie légale.



R. Knapp comments on the implementation of the OIML Certificate System which constitutes an important element for the future of the Organisation. After 12 years representing Canada on the Committee and 3 years as a member of the Presidential Council, Mr Knapp announced his pending retirement and expressed his pleasure for having participated in OIML's development.

M. R. Knapp commente l'application du Système de Certificats OIML qui constitue un élément essentiel pour le futur de l'Organisation. Après douze ans comme membre du Comité représentant le Canada et trois ans comme membre du Conseil de Présidence, M. Knapp annonce sa retraite imminente et exprime le plaisir qu'il a éprouvé à participer au développement de l'OIML.

S. Bennett and L. K. Issaev take note of information concerning OIML activities in developing countries. Based on the diverse experience of the members, the Council prepares initiatives destined to maintain important links between developed and developing countries participating in OIML.

S. Bennett et L. Issaev prennent note des informations relatives aux activités de l'OIML dans les pays en développement. Grâce à l'expérience de ses membres, le Conseil initie des actions destinées à maintenir des liens importants entre pays développés et pays en développement membres de l'OIML.

Agenda of the OIML Presidential Council Meeting
BIML, 10–11 February 1994

1 Work of OIML technical committees and subcommittees in 1993
2 OIML long-term policy
3 General information brochure
4 Miscellaneous matters
  4.1 Certification
  4.2 OIML Bulletin
  4.3 Developing countries
  4.4 Financial situation
5 Other matters
  Preparations for the 29th CIML Meeting
  Place of the Tenth Conference

Training in measurement

THE COMMONWEALTH-INDIA METROLOGY CENTRE (CIMET)

A report given to the OIML Development Council by **Dr B. S. Mathur,** National Physical Laboratory

The Commonwealth-India Metrology Centre (CIMET) was inaugurated at the National Physical Laboratory (NPL), New Delhi, India in February 1989, with the ultimate aim of the elaboration of a Commonwealth centre of excellence for training in metrology and allied areas.

The metrological capability of commonwealth developing countries, like their technological capacities, differs between countries and regions. For some, the evaluation of a national measurement system suited to the local conditions requires, at the outset, appropriate and relevant human resource development, and facilities for intercomparison and calibration and utilization strategies.

THE DEVELOPMENT OF METROLOGY PROGRAMS

It was to meet these needs that the Commonwealth Science Council (CSC) launched a Commonwealth Asia/Pacific Metrology Program in 1977 with the aim of fostering regional collaboration and implementing specific projects in metrology. A number of non-Commonwealth organizations and countries in Asia subsequently joined the program under the sponsorship of ASCA & UNESCO.

Sponsored by the Council of Scientific and Industrial Research (CSIR), CIMET was established to improve the measurement capabilities of developing countries in general and of Commonwealth countries in particular.

In order to fulfill this goal, CIMET strives to address metrological concerns including measurement standards, national capabilities and infrastructure; training in metrology and associated areas; and the dissemination of information dissemination relating to all aspects of metrology.

TRAINING WITH CIMET

Two types of training activities intended to improve the metrology resources and services of Commonwealth countries are offered by CIMET.

Group Training: for 25–30 participants every year for a period of 2–3 weeks including on-the-job training in various fields of metrology.

Individual Training (Research attachment and internships): for 6 trainees each year for a maximum period of 3 months in individually selected fields of metrology.

The CIMET also aims to organize intercomparison activities which provide training of scientist-metrologists by experience with international intercomparisons of measurement standards.

ORGANIZATIONAL ASPECTS

The foundations of CIMET rest on the general aim of facilitating regional needs of training and intercomparisons in the area of metrology. To ensure proper co-ordination and monitoring of CIMET's activities, the following three levels of control have been established:

• STEERING LEVEL
Responsibility of an International Advisory Committee.

• TECHNICAL LEVEL
Supervision of the daily management and coordination with member countries; responsibility of a Standing Technical Committee.

• FUNDING AND MONITORING LEVEL
The responsibility of the National Physical Laboratory, New Delhi is to provided the infrastructure and training facilities. Funding for travel and other expenses of trainees and external faculty is provided by the Fellowship and Training Program/CSC, who together with CSIR, will also monitor the CIMET activities.

EXTENDED PARTICIPATION

The participation of up to 5 non-Commonwealth trainees sponsored by other international agencies such as UNESCO and UNDP is possible. Organizations and agencies such as UNESCO, AIDAB, ASCA, UNDP and ESCAP who participated in the expanded APMP program until 1989, are encouraged to provide financial support for scientists/metrologists from non-Commonwealth countries to participate in the Centre's training programs.

INITIAL EXPERIENCE OF THE CIMET TRAINING PROGRAMS

The International Advisory Committee for CIMET, in its first meeting in February 1989, outlined the details of a three-year training program in which both Group and Individual Training Programs were to be arranged in the first two years and only an Individual Training and Research Attachment Program in the third year.

The first CIMET Group Training Workshop in Metrology was held at National Physical Laboratory from 28 November to 8 December 1989. The areas covered in the Workshop were Mass, Length, Volume and Temperature measurements.

Participation

Twelve participants attended the Workshop from 11 Commonwealth countries: Zimbabwe, Malaysia, Seychelles, Kenya, Malta, Uganda, Papua New Guinea, Guyana, Cyprus, Ghana, Bangladesh as well as two participants from Saudi-Arabia.

Faculty

Two faculty members from abroad also took part in the Workshop as resource persons: Mr. J. J. Connolly from National Measurement Laboratory, Sydney, Australia and Dr Kailash Chandra, UNDP Expert in Metrology from Saudi Arabia.

The Indian faculty for the workshop was drawn from the National Physical Laboratory, Bureau of Indian Standards, Department of Weights and Measures, Government of India and Controllorates of Weights and Measures, Delhi Administration and Government of Assam.

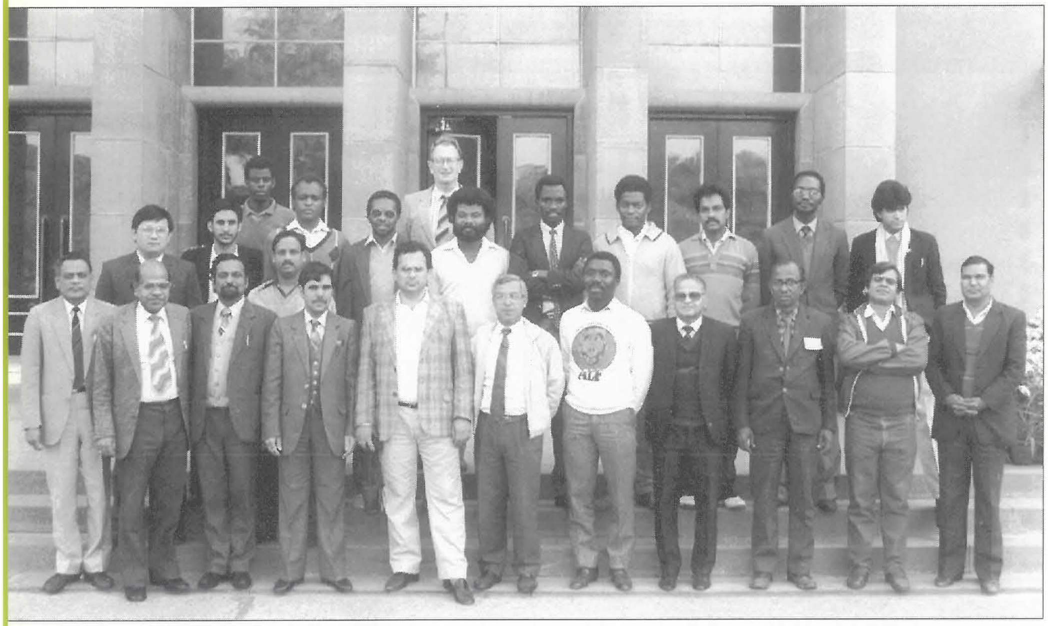
Program

A total of 28 lectures were delivered during the workshop on subjects including standards, calibration and testing, and legal metrology. In addition to the lectures, the participants were given experimental demonstrations in various laboratories of the National Physical Laboratory connected with the areas of training and were shown the facilities of the Standards Group of the National Physical Laboratory.

Field trips were arranged to B.I.S. Central Laboratory in Sahibabad; Laboratory of Weights and Measures Controllorate in Wazirpur; Bharat Petroleum Corporation in Sakur Basti; Hindustan Vegetable Oil Corporation prepackaging unit; and the Taximeter Testing Laboratory of Delhi Administration in Khyber Pass.

Subjects addressed in the CIMET training programs

- S.I. Units
- Length
- Mass
- Time and frequency
- Density
- Volume
- Force
- Pressure
- Vacuum
- Weights and measures laws
- National certification schemes
- Calibration programs
- Measurement systems in different countries
- Regulations for pre-packaged products
- D.C. current and voltage
- Low frequency-voltage, power and energy
- Low frequency impedance
- High frequency-voltage, power
- High frequency impedance
- Temperature
- Photometry, calorimetry and radiometry
- Acoustics
- Ultrasonics
- Microwaves



Staff and Trainees at the National Physical Laboratory.

Reference standards (resistance and capacitance) that had been brought by the participants from Saudi Arabia were calibrated at NPL with active involvement of trainees during calibration.

The first CIMET Individual Training and Research Attachment Program was held at National Physical Laboratory, New Delhi from 20 November 1989 to 19 February 1990. Two participants from Ghana and Kenya attended this program and were given intensive training in selected parameters.

RECENT EXPERIENCE

The second Group Training Workshop was held at the National Physical Laboratory from 25 February to 13 March 1992. The areas covered in this workshop were: Direct Current, Low Frequency, High Frequency, Microwave Frequency and Time and Frequency Measurements.

Thirteen participants attended this workshop from 9 Commonwealth Countries: Ghana, Malaysia, Malawi, Pakistan, Tanzania, Zimbabwe, Botswana, Namibia and Bangladesh.

Almost 30 lectures on standards, calibration and testing were delivered during the workshop. A unique feature of this workshop was that the lecture-cum-demonstration programs for three full days were arranged at the BIS and STQC laboratories. Field trips to the manufacturers of electronic instruments were also organized.

The Second Individual Training and Research Attachment Program was held at NPL, New Delhi in Spring 1992. Five participants from Ghana, Zimbabwe, Namibia and Pakistan and four participants from Saudi Arabia attended this program.

The Individual Programs were intentionally planned to overlap with the Group Training Workshop so that the participants could have the benefit of lectures and experimental demonstrations in other subjects.

OTHER CIMET ACTIVITIES

A Directory of Capabilities of National Measurement Systems of Commonwealth Member Countries was published by CIMET in February 1993. This directory contains metrological information gathered from 25 Commonwealth Countries and will be updated as information from more Commonwealth countries is received.

A 20-minute video film on "Need for Metrology" was completed through CIMET in collaboration with the Asia/Pacific Metrology Program (APMP) in 1992 and has been widely distributed both by CIMET and APMP.

FUTURE PLANS FOR CIMET

▶ **DIRECTORY**

A Directory of Capabilities of National Measurement Systems similar to the one published by CIMET in 1993 for Commonwealth countries, is planned for the NAM countries.

▶ **INTERNATIONAL COOPERATION**

Efforts to increase interaction with Asia/Pacific Metrology Programme (APMP), International Organisation of Legal Metrology (OIML), International Bureau of Weights and Measures (BIPM) and other international metrological organizations.

▶ **INTERNATIONAL INTERCOMPARISONS**

Within Commonwealth as well as non-Commonwealth countries. Efforts will be made to make this a joint venture between APMP and CIMET with special emphasis to serve the African and Caribbean countries.

▶ PUBLICATIONS

Efforts to edit and print the lectures and demonstration notes of the two Group Training Workshops held at NPL in November–December 1989 and February–March 1992.

▶ NEW TRAINING PROGRAM

A Group Training Program on "Metrology in Quality Management and Quality Improvement" will be organized by CIMET 23 May–10 June 1994 at NPL, New Delhi. The participants should be practising metrologists or measurement, standards and quality control officers working in the field of metrology.

▶ WORKSHOP

A joint workshop on "International Recognition of National Physical Standards in Developing Countries" with the participation of CIMET and APMP has been suggested for 1994 and is under consideration.

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COMMONWEALTH MEMBERS
(as of 31 July 1993)

- Antigua & Barbuda
- Australia
- Bahamas
- Bangladesh
- Barbados
- Belize
- Botswana
- Britain
- Brunei Darussalam
- Canada
- Cyprus
- Dominica
- The Gambia
- Ghana
- Grenada
- Guyana
- India
- Jamaica
- Kenya
- Kiribati
- Lesotho
- Malawi
- Malaysia
- Maldives
- Malta
- Mauritius
- Namibia
- Nauru
- New Zealand
- Nigeria
- Pakistan
- Papua New Guinea
- St Kitts & Nevis
- St Lucia
- St Vincent & the Grenadines
- Seychelles
- Sierra Leone
- Singapore
- Solomon Islands
- Sri Lanka
- Swaziland
- Tanzania
- Tonga
- Trinidad & Tobago
- Tuvalu
- Uganda
- Vanuatu
- Western Samoa
- Zambia
- Zimbabwe

EC verification in practice*

THE UK EXPERIENCE WITH NONAUTOMATIC WEIGHING INSTRUMENTS

D. Beardsley and M. Harvey, West Sussex Country Council, United Kingdom

Since first obtaining Approved Body Status, West Sussex has had several opportunities to put to test its new powers.

The experience has proved to be quite an eye opener and we hope that by sharing our experiences with our colleagues we will help them prepare for their first dealing with Non-UK Certificates of Approval and the Non-Automatic Weighing Instruments Regulations 1992.

Already we have had scales submitted to us by Espera Scales Ltd. (through a referral by Surrey Trading Standards), Avery-Berkel (through a referral by Hampshire Trading Standards) and Spectra Physics at a supermarket within West Sussex. As neither Surrey nor Hampshire are yet Approved Bodies under the Regulations, they invited us to verify the equipment.

The Espera sales are tested at our Crawley office but the Avery-Berkel scales can only be tested in situ which meant us going into Hampshire. As a matter of courtesy we were formally invited. Steps were taken to confirm insurance cover out of Country and a temporary warrant was issued to overcome legal problems with the Local Government Act 1972.

The Espera experience is probably the most interesting example to relate, their machines being amongst the most sophistical you are likely to see in this category. Their scales are imported into the UK from Germany and submitted to us for verification under an EC Type Approval Certificate issued by NMi (Nederlands Meetinstituut).

THE MACHINES SUBMITTED

Apart from the fact that they were the first machines submitted to us for verification under the new regime, the Espera machines were most interesting in themselves. They were submitted for verification under a new EC Type Approval Certificate issued by NMi and as would appear to be the case with Dutch Certificates, approved a family of machines with an assortment of combinations of peripherals.

Our machines were of modular construction being in 3 parts: load receptor, printer, and terminal (incorporating the display and Control Key Pad). They were equipped with metric and 1 or 2 imperial ranges (pounds and decimals of a pound and pound and ounces) as well as the ranges being subdivided into up to 3 partial weighing ranges (with different size increments). A tare and ticket printer facility was available as required operating over all intervals and ranges making the machines among the most complicated we could have imagined!

EXAMINATION OF THE EC TYPE APPROVED CERTIFICATE

An EC type approval certificate issued by NMi, is a very different document from the familiar NWML Notice of Approval. In this case, the certification consisted of one page on which was described the type of machine to which it related, and its characteristics (capacity, scale intervals, weight ranges, intervals, tare, units, etc).

It also introduced further documentation as two separate documents both of which appertained to this particular EC type approval certificate.

* This article is reproduced from *The Trading Standards Review*, February 1994, the publication of the Institute of Trading Standards Administration, Hadleigh (Essex), United Kingdom.

The description was a 4-page text describing essential parts, shapes and characteristics along with information about the main constituent parts. The document folder contained a list of drawing numbers plus the respective drawings themselves, all of which ought to bear the NMi stamp.

It would have been impossible to properly verify the machines without these 3 constituent parts of the approval document (the documentation folder, in particular, being vital). It was very interesting to note that no photographs were included.

Close examination of the notice is important even to the extent of checking circuit component diagrams. We found that on a circuit board of one of the printers submitted, a "chip" had a number of different digits from the one on the diagram. This was checked by Espera who were able to confirm that the particular printer did not in fact conform to the notice in respect of its speed response circuit, so it was replaced with another module. This point illustrated the fact that detailed examination is vital since the only was of detecting the response speed of the approved printer was by the one component number that we picked out.

We consulted NWML for guidance on the degree of latitude in respect of circuit checks and agreed that officers needed to seek confirmation from a manufacturer that the number printed on a component related to a unit performing the same task as that shown in the approval documents. Supplier's numbers might differ, but its core component number would be the same.

We then had to advise Espera on the layout and details required for the data plate since the plates required information relating to pounds and decimal pounds as well as kilogrammes. This was a more difficult task than it sounded due to the various intervals within its respective ranges.

TESTING

Having established that the machines conformed to the type approval certificate, we then had to determine the appropriate tests we needed to apply. This really brought home the benefits of having a quality system in place. Using the test sheets we had drawn up for non-automatic weighing machines we established the weight values that we needed to apply and completed master test sheets for the machines in question. These have been filed as "master copies" and will save, literally, hours of work when future machines are submitted.

Regulation 14(8) of the Non-Automatic Weighing Instruments (EEC Requirements) Regulations 1992 states that the appropriate examinations and tests should include those specified in the relevant harmonized standard. It was interesting therefore to determine the required tests by reference to European Standard, EN 45501 rather than by solely tests from the Regulations, and Notice of Approval.

Having satisfactorily completed the tests we then were able to affix the appropriate stickers, after we had ascertained that the CE mark could be properly applied. This was confirmed by the submitter on our "booking in" form.

CONCLUSION

The chain of events from "submission" to "stamping" was a most interesting exercise in re-thinking the practices we have followed for years. All steps were logical but a few held surprises, the last of which being that even the application of stickers is not quite what it would appear to be - the weather was very warm and the stickers came off the roll still attached to the backing paper!

We hope that this outline of our experiences will be of assistance to our colleagues when they are faced with their first EC verification. ■

activities
OIML
activités

Following is an overview of the development of OIML technical activities and publications based on the annual reports for 1993. For each active technical committee and subcommittee, the work project is listed together with the state of progress for 1993 and projections for 1994 when appropriate. A key for the presentation of this information is given below:

Ci-après vous trouverez un récapitulatif du développement des travaux techniques et publications de l'OIML sur la base des rapports annuels pour 1993. Pour chaque comité technique ou sous-comité actif, le thème de travail est donné avec des informations concernant l'état d'avancement pour 1993 ainsi que les prévisions pour 1994 si approprié. Ces informations sont présentées sous la forme suivante:

State of progress for 1993	Projections for 1994

Avancement des travaux pour 1993	Prévisions pour 1994

State of progress for 1993 Projections for 1994	Code	Etat d'avancement pour 1993 Prévisions pour 1994
Working draft (Preparatory stage)	WD	Projet de travail (Stade de préparation)
Committee draft (Committee stage)	CD	Projet de comité (Stade de comité)
Draft Recommendation or Document (Approval stage)	DR/DD	Projet de Recommandation ou de Document (Stade d'approbation)
Vote by correspondence on the draft	VOTE CIML	Vote par correspondance sur le projet
CIML approval or submitted to CIML for approval	CIML	Approbation ou présentation pour approbation par le CIML
International Document (Publication stage)	D	Document International (Stade de publication)
International Recommendation (Publication stage)	R	Recommandation Internationale (Stade de publication)

TC 1 – Poland **Terminology**			**TC 1 – Pologne** **Terminologie**
Revision V 1: Vocabulary of legal metrology	-	WD	Révision V 1: Vocabulaire de métrologie légale
TC 2 – Austria **Units of measurement**			**TC 2 – Autriche** **Unités de mesure**
Revision D 2: Legal units of measurement	3 CD	DD	Révision D 2: Unités de mesure légales
TC 3 – USA **Metrological control**			**TC 3 – USA** **Contrôle métrologique**
TC 3/SC 1 **Pattern approval and verification**			TC 3/SC 1 **Approbation de modèle et vérification**
Initial verification of measuring instruments utilizing the manufacturer's quality system	2 CD	DD	Vérification primitive des instruments de mesure utilisant le système qualité du constructeur
TC 4 – Slovakia **Measurement standards and calibration and verification devices**			**TC 4 – Slovaquie** **Etalons de mesure et dispositifs d'étalonnage et de vérification**
Principles for the selection and expression of metrological characteristics of standards and devices used for calibration and verification	-	WD	Principes du choix et de l'expression des caractéristiques métrologiques des étalons et des dispositifs utilisés pour l'étalonnage et la vérification
Revision D 5: Principles for the establishment of hierarchy schemes for measuring instruments	-	WD	Révision D 5: Principes pour l'établissement des schémas de hiérarchie des instruments de mesure
Revision D 10: Recalibration intervals of measurement standards and calibration devices	-	WD	Révision D 10: Conseils pour la détermination des intervalles de réétalonnage des équipements de mesure utilisés dans les laboratoires d'essais
Revision D 23: Principles of the metrological control of devices used for verification	-	WD	Révision D 23: Principes du contrôle métrologique des équipements utilisés pour la vérification
TC 5 – Netherlands **Electronic instruments**			**TC 5 – Pays-Bas** **Instruments électroniques**
Revision D 11: General requirements for electronic measuring instruments	DD	CIML	Révision D 11: Exigences générales pour les instruments de mesure électroniques
TC 6 – USA **Prepackaged products**			**TC 6 – USA** **Produits préemballés**
Revision R 79: Information on package labels	WD	WD	Révision R 79: Etiquetage des préemballages
Revision R 87: Net content in packages	WD	WD	Révision R 87: Contenu net des préemballages

TC 7 – United Kingdom **Measuring instruments for length and associated quantities**			**TC 7** – Royaume-Uni **Instruments de mesure des longueurs et grandeurs associées**
TC 7/SC 1 – Russian Federation **Measuring instruments for length**			TC 7/SC 1 – Fédération de Russie **Instruments de mesure des longueurs**
Revision R 30: End standards of length (gauge blocks)	*Awaiting revision of ISO Standard 3650* *En attente de la révision de la Norme ISO 3650*		Révision R 30: Mesures de longueur à bouts plans (cales étalons)
Revision R 66: Length measuring instruments	-	WD	Révision R 66: Instruments mesureurs de longueurs
TC 7/SC 3 – Hungary **Measurement of areas**			TC 7/SC 3 – Hongrie **Mesurage des surfaces**
Instruments for measuring the areas of leather	4 CD	DR	Instruments de mesure de la superficie des cuirs
TC 7/SC 4 – United Kingdom **Measuring instruments for road traffic**			TC 7/SC 4 – Royaume-Uni **Instruments de mesure pour la circulation routière**
Revision R 55: Speedometers, mechanical odometers and chronotachographs for motor vehicles. Metrological regulations	3 CD	4 CD	Révision R 55: Compteurs de vitesse, compteurs mécaniques de distance et chronotachygraphes des véhicules automobiles. Réglementation métrologique
TC 7/SC 5 – Australia **Dimensional measuring instruments**			TC 7/SC 5 – Australie **Instruments de mesures dimensionnelles**
Metrological and technical requirements, test procedures and pattern evaluation report for dimensional measuring instruments	WD	1 CD	Exigences métrologiques et techniques, procédures d'essai et rapport d'essai de modèle pour les instruments de mesures dimensionnelles
TC 8 – Switzerland **Measurement of quantities of fluids**			**TC 8** – Suisse **Mesurage des quantités de fluides**
Characteristics of standard capacity measures and test methods for measuring systems	DR	Vote CIML CIML	Caractéristiques des mesures de capacité étalons et méthodes d'essai des systèmes de mesurage
Pipe provers for testing of measuring systems for liquids	DR	Vote CIML CIML	Tubes étalons pour l'évaluation des ensembles de mesurage pour liquides
Revision R 63: Petroleum measurement tables	CIML	R	Révision R 63: Tables de mesure du pétrole
Vortex meters	DD	Vote CIML	Compteurs à vortex
TC 8/SC 2 – Australia **Static mass measurement**			TC 8/SC 2 – Australie **Mesurage statique massique**
Static direct mass measurement of quantities of liquid	4 CD	DR	Mesurage statique massique direct des quantités de liquides
TC 8/SC 3 – Germany **Dynamic volume measurement (liquids other than water)**			TC 8/SC 3 – Allemagne **Mesurage dynamique volumique (liquides autres que l'eau)**
Measuring assemblies for liquids other than water (Revision R 5, R 27, R 57, R 67, R 77)	DR	DR	Ensembles de mesurage de liquides autres que l'eau (Révision R 5, R 27, R 57, R 67, R 77)
Testing procedures for pattern examination of fuel dispenser for motor vehicles	DD	Vote CIML CIML	Procédures d'essai pour l'examen des modèles de distributeurs routiers pour véhicules à moteur

TC 8/SC 4 – USA **Dynamic mass measurement (liquids other than water)**			TC 8/SC 4 – USA **Mesurage dynamique massique (liquides autres que l'eau)**
Annex R 105: Test report format for the evaluation of direct mass flow measuring systems for quantities of liquids	3 CD Vote CIML	-	Annexe R 105: Format du rapport d'essai des ensembles de mesurage massiques directs de quantités de liquides
TC 8/SC 5 – UNITED KINGDOM **Water meters**			TC 8/SC 5 – ROYAUME-UNI **Compteurs d'eau**
Revision R 49: Water meters intended for the metering of cold water	DR Vote CIML	CIML	Révision R 49: Compteurs d'eau destinés au mesurage de l'eau froide
TC 8/SC 6 – USA **Measurement of cryogenic liquids**			TC 8/SC 6 – USA **Mesurage des liquides cryogéniques**
Revision R 81: Measuring devices and measuring systems for cryogenic liquids (including tables of density for liquid argon, helium, hydrogen, nitrogen and oxygen)	-	CD	Révision R 81: Dispositifs et systèmes de mesure de liquides cryogéniques (comprend tables de masse volumique pour argon, hélium, hydrogène, azote et oxygène liquides)
TC 8/SC 8 – NETHERLANDS **Gas meters**			TC 8/SC 8 – PAYS-BAS **Compteurs de gaz**
Revision R 6: General provisions for gas volume meters	-	WD	Révision R 6: Dispositions générales pour les compteurs de volume de gaz
Revision R 31: Diaphragm gas meters	CD	DR	Révision R 31: Compteurs de volume de gaz à parois déformables
Revision R 32: Rotary piston gas meter and turbine gas meters	WD	WD	Révision R 32: Compteurs de volume de gaz à pistons rotatifs et compteurs de volume de gaz à turbine
TC 9 – USA **Instruments for measuring mass and density**			**TC 9** – USA **Instruments de mesure des masses et masses volumiques**
Annex R 60: Test report format for the evaluation of load cells	CIML R	-	Annexe R 60: Format du rapport d'essai des cellules de pesée
TC 9/SC 2 – UNITED KINGDOM **Automatic weighing instruments**			TC 9/SC 2 – ROYAUME-UNI **Instruments de pesage à fonctionnement automatique**
Revision R 50: Continuous totalizing weighing instruments	CIML	R	Révision R 50: Instruments de pesage totalisateurs continus
Annex R 50: Test procedures and format of the test report for the evaluation of continuous totalizing automatic weighing machines	DR	Vote CIML	Annexe R 50: Procédures d'essai et format du rapport d'essai des instruments de pesage totalisateurs continus à fonctionnement automatique
Revision R 51: Automatic catchweighing instruments (including test procedures and test report format as separate papers)	5 CD	6 CD DR	Révision R 51: Instruments trieurs-étiqueteurs à fonctionnement automatique (incluant procédures d'essai et format de rapport d'essai sous forme de textes séparés)
Revision R 61: Automatic gravimetric filling machines	6 CD	7 CD DR	Révision R 61: Doseuses pondérales à fonctionnement automatique

Annex R 106: Test procedures and format of the test report for the evaluation of automatic rail-weighbridges	DR	Vote CIML	Annexe R 106: Procédures d'essai et format du rapport d'essai des ponts-bascules ferroviaires à fonctionnement automatique
Annex R 107: Test procedures and format of the test report for the evaluation of discontinuous totalizing automatic weighing instruments	DR	Vote CIML	Annexe R 107: Procédures d'essai et format du rapport d'essai des instruments de pesage totalisateurs discontinus à fonctionnement automatique
TC 9/SC 3 – USA **Weights**			TC 9/SC 3 – USA **Poids**
R 111: Weights of accuracy classes E_1, E_2, F_1, F_2, M_1, M_2, M_3	CIML	R	R 111: Poids des classes de précision E_1, E_2, F_1, F_2, M_1, M_2, M_3
TC 10 – USA **Instruments for measuring pressure, force, and associated quantities**			**TC 10** – USA **Instruments de mesure des pressions, forces et grandeurs associées**
TC 10/SC 1 – BULGARIA, CZECH REPUBLIC **Pressure balances**			TC 10/SC 1 – BULGARIE, RÉPUBLIQUE TCHÈQUE **Balances manométriques**
R 110: Pressure balances	CIML	R	R 110: Manomètres à piston
TC 10/SC 2 – RUSSIAN FEDERATION **Pressure gauges with elastic sensing elements**			TC 10/SC 2 – FÉDÉRATION DE RUSSIE **Manomètres à élément récepteur élastique**
Pressures transmitters with elastic sensing elements	-	WD	Transmetteurs de pression à élément récepteur élastique
Annex R 101: Test procedures and test report format for the evaluation of pressure gauges with elastic sensing elements (ordinary instruments)	CD	CD	Annexe R 101: Procédures d'essai et format du rapport d'essai des manomètres, vacuomètres et manovacuomètres indicateurs et enregistreurs à élément récepteur élastique (instruments usuels)
Annex R 109: Test procedures and test report format for the evaluation of pressure gauges with elastic sensing elements (standard instruments)	CD	CD	Annexe R 109: Procédures d'essai et format du rapport d'essai des manomètres et vacuomètres à élément récepteur élastique (instruments étalons)
TC 10/SC 4 – USA **Material testing machines**			TC 10/SC 4 – USA **Machines d'essai des matériaux**
Requirements for force measuring instruments for verifying material testing machines	WD	1 CD	Exigences pour les instruments de mesure de la force utilisés pour vérifier les machines d'essai des matériaux
Force measuring systems of material testing machines (Revision R 64: General requirements for material testing machines + Revision R 65: Requirements for machines for tension and compression testing)	1 CD	2 CD	Systèmes de mesure de force des machines d'essai des matériaux (Révision R 64: Exigences générales pour les machines d'essai des matériaux + Révision R 65: Exigences pour les machines d'essai des matériaux en traction et en compression)
TC 10/SC 5 – USA **Hardness standardized blocks and hardness testing machines**			TC 10/SC 5 – USA **Blocs de référence de dureté et machines d'essai de dureté**
International intercomparison of hardness blocks – Work program	-	Work Program Programme de travail	Intercomparaison internationale des blocs de dureté – Programme de travail
TC 10/SC6 – USA **Strain gauges**			TC 10/SC6 – USA **Jauges de contrainte**
Revision R 62: Strain gauges	-	WD 1 CD	Révision R 62: Jauges de contrainte

TC 11 – Germany		**TC 11 – Allemagne**
Instruments for measuring temperature and associated quantities		**Instruments de mesure de la température et grandeurs associées**
Metallic electrical platinum, copper and nickel resistance thermometers with extended range	WD | 1 CD	Thermomètres à résistance électrique de platine, cuivre et nickel à étendue élargie
TC 11/SC 2 – Russian Federation		TC 11/SC 2 – Fédération de Russie
Pyrometers		**Pyromètres**
Blackbodies for the calibration of optical pyrometers	WD | 1 CD	Corps noirs pour l'étalonnage des pyromètres optiques
TC 11/SC 3 – Germany		TC 11/SC 3 – Allemagne
Measurement of heat		**Compteurs d'énergie thermique**
Revision R 75: Heat meters	- | Coordination with CEN	Révision R 75: Compteurs d'énergie thermique
TC 12 – Germany		**TC 12 – Allemagne**
Instruments for measuring electrical quantities		**Instruments de mesure des grandeurs électriques**
Revision R 46: Active electrical energy meters	WD | WD	Révision R 46: Compteurs d'énergie électrique active.
TC 13 – Germany		**TC 13 – Allemagne**
Measuring instruments for acoustics and vibration		**Instruments de mesure pour l'acoustique et les vibrations**
Annex R 58: Test report format for the evaluation of sound level meters	- | WD	Annexe R 58: Format du rapport d'essai des sonomètres
Annex R 88: Test report format for the evaluation of integrating-averaging sound level meters	- | WD	Annexe R 88: Format du rapport d'essai des sonomètres intégrateurs-moyenneurs
Annex R 102: Test procedures and format of the test report for the evaluation of sound calibrators	DR | Vote CIML CIML	Annexe R 102: Procédures d'essai et format du rapport d'essai des calibreurs acoustiques
Revision R 104: Pure-tone audiometers	- | WD	Révision R 104: Audiomètres à sons purs
Speech audiometers	DR | -	Audiomètres pour la parole
TC 14 – Hungary		**TC 14 – Hongrie**
Measuring instruments used for optics		**Instruments de mesure utilisés en optique**
Revision R 93: Focimeters	WD | 1 CD	Révision R 93: Frontofocomètres
Illuminance meters	WD | WD	Luxmètres
TC 15 – Russian Federation		**TC 15 – Fédération de Russie**
Measuring instruments for ionizing radiations		**Instruments de mesure pour rayonnements ionisants**
Routine dye-film dosimetry system	WD | 1 CD	Système de dosimétrie de routine par film coloré

TC 16 – USA
Instruments for measuring pollutants

TC 16 – USA
Instruments de mesure des polluants

TC 16/SC 1 – NETHERLANDS
Air pollution

TC 16/SC 1 – PAYS-BAS
Pollution de l'air

Continuous measuring instruments for NO_x emissions	-	WD	Instruments de mesure en continu des émissions de NO_x
Continuous measuring instruments for SO_2 emissions	-	WD	Instruments de mesure en continu des émissions de SO_2
Continuous measuring instruments for CO emissions	-	WD	Instruments de mesure en continu des émissions de CO
Revision R 99: Instruments for measuring vehicle exhaust emissions	-	WD	Révision R 99: Instruments de mesure des gaz d'échappement des véhicules

TC 16/SC 2 – USA
Water pollution

TC 16/SC 2 – USA
Pollution de l'eau

Inductively coupled plasma atomic emission spectrometers for measuring metal pollutants in water	DR	Vote CIML CIML	Spectromètres à plasma d'émission atomique couplés inductivement pour la mesure des polluants métalliques dans l'eau
Revision R 83: Gas chromatograph – mass spectrometer	-	WD	Révision R 83: Chromatographe en phase gazeuse – spectromètre de masse
Revision R 100: Atomic absorption spectrometers for measuring metal pollutants in water	-	WD	Révision R 100: Spectromètres à absorption atomique pour la mesure des polluants métalliques dans l'eau

TC 16/SC 3 – USA
Pesticides and other toxic substances pollutants

TC 16/SC 3 – USA
Pesticides et autres substances polluantes toxiques

Revision R 82: Gas chromatographs for measuring pollution from pesticides and other toxic substances	-	WD	Révision R 82: Chromatographes en phase gazeuse pour la mesure des pollutions par pesticides et autres substances toxiques
R 112: High performance liquid chromatographs for measurement of pesticides and other toxic substances	CIML	R	R 112: Chromatographes en phase liquide pour la mesure des pesticides et autres substances toxiques

TC 16/SC 4 – USA
Field measurements of hazardous (toxic) pollutants

TC 16/SC 4 – USA
Mesures de terrain des polluants dangereux (toxiques)

R 113: Portable gas chromatographs for field measurements of hazardous chemical pollutants	CIML	R	R 113: Chromatographes en phase gazeuse portatifs pour la mesure sur site des polluants chimiques dangereux
Portable and transportable X-ray fluorescence spectrometers for field measurements of hazardous elemental pollutants	1 CD	2 CD	Spectromètres fluorescents à rayons X portatifs et déplaçables pour la mesure sur le terrain des éléments polluants dangereux
Air sampling devices for toxic chemical pollutants at hazardous waste sites	WD	1 CD	Dispositifs échantillonneurs d'air pour polluants chimiques toxiques sur les sites de décharge de déchets dangereux
Fourier transform infrared spectrometers for measurement of hazardous chemical products	WD	1 CD	Spectromètres en infrarouge à transformée de Fourier pour la mesure des produits chimiques dangereux

English			Français
TC 17 – Russian Federation **Instruments for physico-chemical measurements**			**TC 17** – Fédération de Russie **Instruments pour mesurages physico-chimiques**
TC 17/SC 2 – Russian Federation **Saccharimetry**			TC 17/SC 2 – Fédération de Russie **Saccharimétrie**
Revision R 14: Polarimetric saccharimeters	DR	Vote CIML CIML	Révision R 14: Saccharimètres polarimétriques
TC 17/SC 3 – Russian Federation **pH-metry**			TC 17/SC 3 – Fédération de Russie **pH-métrie**
Revision R 54: pH-scale for aqueous solutions	WD	1 CD	Révision R 54: Echelle de pH des solutions aqueuses
TC 17/SC 5 – Russian Federation **Viscometry**			TC 17/SC 5 – Fédération de Russie **Viscosimétrie**
Reference standard liquids for the calibration and verification of viscometers	DR	DR	Liquides étalons de référence pour l'étalonnage et la vérification des viscosimètres
TC 18 – Germany **Medical measuring instruments**			**TC 18** – Allemagne **Instruments de mesure médicaux**
Ergometers	-	Work Program Programme de travail	Ergomètres
TC 18/SC 1 – Austria **Blood pressure instruments**			TC 18/SC 1 – Autriche **Instruments pour pression sanguine**
Revision R 16: Manometers for instruments for measuring blood pressure (sphygmomanometers)	3 CD	4 CD (coordination with CEN)	Révision R 16: Manomètres des instruments de mesure de la tension artérielle (sphygmomanomètres)
TC 18/SC 2 – Germany **Medical thermometers**			TC 18/SC 3 – Allemagne **Thermomètres médicaux**
Continuous measuring clinical electrical thermometers	Vote CIML	CIML	Thermomètres médicaux électriques pour mesure en continu
Clinical electrical thermometers with maximum device	Vote CIML	CIML	Thermomètres médicaux électriques avec dispositif à maximum
TC 18/SC 4 – Russian Federation **Bio-electrical instruments**			TC 18/SC 4 – Fédération de Russie **Instruments bio-électriques**
Electrodes for electrocardiographs and electroencephalographs – Methods and means for verification	CD	DR	Electrodes pour électrocardiographes et électroencéphalographes – Méthodes et moyens de vérification
Annex R 90: Electrocardioscopes – Metrological characteristics – Methods and means for verification	CD	DR	Annexe R 90: Electrocardioscopes – Caractéristiques métrologiques – Méthodes et moyens de vérification
Digital electrocardiographs and electrocardioscopes	CD	DR	Electrocardiographes et électrocardioscopes numériques
TC 18/SC 5 – Germany **Measuring instruments for medical laboratories**			TC 18/SC 5 – Allemagne **Instruments de mesure pour laboratoires médicaux**
Absorption photometers	WD	1 CD	Photomètres à absorption

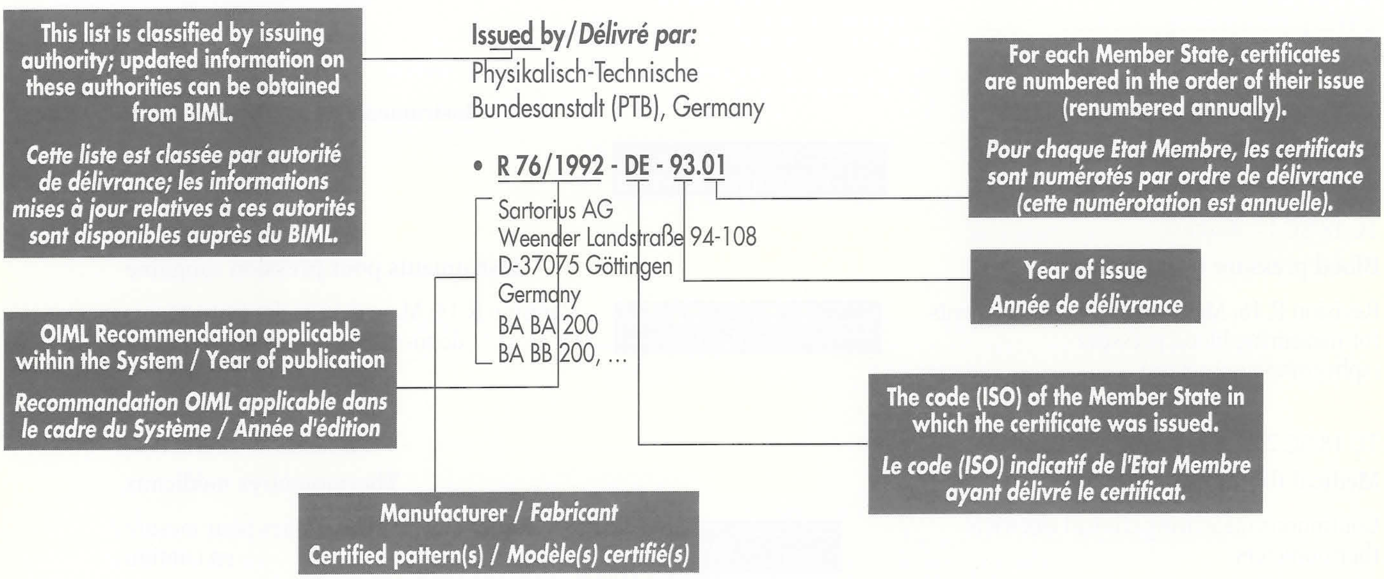
OIML certificate system / Système de certificats OIML

OIML CERTIFICATES registered from December 1993 to February 1994

CERTIFICATS OIML enregistrés de décembre 1993 à février 1994

HOW TO USE THE LIST OF OIML CERTIFICATES

COMMENT UTILISER LA LISTE DES CERTIFICATS OIML



INSTRUMENT CATEGORY **Nonautomatic weighing instruments R 76-1 (1992), R 76-2 (1993)**

CATÉGORIE D'INSTRUMENT **Instruments de pesage à fonctionnement non automatique R 76-1 (1992), R 76-2 (1993)**

Issued by/*Délivré par:*
Secretariat for OIML Affairs
State Bureau of Technical Supervision
China

- **R 76/1992-CN-93.01**
  Shanghai Dongchang
  Yamato Scale Co. Ltd
  316 Laoshan Dong Road Shanghai
  China
  ACS-3A, ACS-6A, ACS-15A (Class III)

Issued by/*Délivré par:*
Physikalisch-Technische
Bundesanstalt (PTB)
Germany

- **R 76/1992-DE-93.03**
  Sartorius AG
  Weender Landstraße 94-108
  D-37075 Göttingen
  Germany
  BB BA 200 and BB BB 200 (Class II)

- **R 76/1992-DE-93.04**
  Sartorius AG
  Weender Landstraße 94-108
  D-37075 Göttingen
  Germany
  BA BB 212 (Class II)

- **R 76/1992-DE-93.05**
  PAG Oerlikon AG
  Wallisellenstraße 333, CH 8050
  Zürich, Switzerland
  Series 300 and 310 (Class II)

Issued by/*Délivré par:*
NMi IJkwesen B.V.,
The Netherlands

- **R 76/1992-NL-93.06**
  Mettler-Toledo AG
  Im Langacher, 8606 Greifensee
  Switzerland
  AT 20, AT 21, AT 200,
  AT 201, AT 261, AT 400,
  AT 460, MT 5, UMT 2,
  UMT 5 (Class I)

- **R 76/1992-NL-93.14 Rev. 1**
  Ohaus Corporation
  29, Hanover Road, Florham Park,
  NJ 07932, USA
  AS...E (Class I)
  AS...E (Class II)

- **R 76/1992-NL-93.15**
  A&D Instruments Ltd
  Abingdon Science Park, Abingdon
  Oxford
  OX14 3YS United Kingdom
  FX-EC (Class II)

- **R 76/1992-NL-93.16 Rev. 1**
  A&D Instruments Ltd
  Abingdon Science Park, Abingdon
  Oxford
  OX14 3YS United Kingdom
  FS (Class III)

- **R 76/1992-NL-94.01**
  Tokyo Electric Co. (TEC), Ltd
  6-78, Minami-cho, Mishima-shi
  Shizuoka-ken, 411
  Japan
  SL-5700 (Class III)

LOAD CELLS CAN NOW BE OIML CERTIFIED

The publication of Annex A to OIML R 60 "Test report format for the evaluation of load cells" now makes it possible for these load cells to receive OIML certificates if they satisfy the metrological and technical requirements specified in R 60. The tests must be conducted as indicated in the Recommendation and the results must be reported in the format provided in Annex A.

MANUFACTURERS: TAKE NOTE

This certification of an essential module for weighing instruments is expected to be of great interest to the industrials concerned. Indeed, incorporating a load cell that conforms to OIML R 60 into a weighing instrument will constitute an indication (without being a condition neither necessary nor sufficient) that the entire instrument will satisfy OIML R 76 or other OIML Recommendations on automatic weighing instruments.

The maximum permissible errors (mpe) for the load cell are equal to 0.7 times the mpe of the complete instrument and the remaining 0.3 is attributed to mechanical errors of the instrument itself or to errors of indication.

Manufacturers therefore have an interest in producing or choosing load cells that are certified in conformity with OIML R 60.

A certain number of OIML Member States have already appointed national issuing authorities for the OIML certification of load cells: Denmark, France, Netherlands, United Kingdom, and Switzerland and the first OIML certificates are expected in the near future. ■

LES CELLULES DE PESEE PEUVENT MAINTENANT ETRE CERTIFIEES OIML

La publication de l'Annexe A à OIML R 60 "Format de rapport d'essai des cellules de pesée" permet à ces capteurs de recevoir des certificats OIML s'ils satisfont aux exigences métrologiques et techniques spécifiées dans R 60. Les essais doivent être conduits comme indiqué dans cette Recommandation et leurs résultats doivent faire l'objet d'un rapport d'essai dans le format de l'Annexe A.

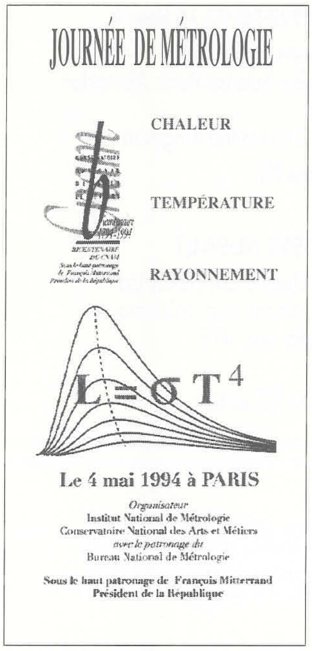
CONTRUCTEURS: PRENEZ NOTE

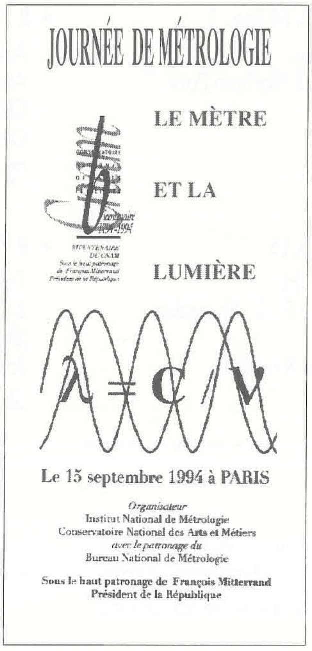
Cette certification d'un élément (module) essentiel des instruments de pesage devrait présenter un grand intérêt pour les industriels concernés. En effet, l'utilisation d'une cellule conforme à OIML R 60 comme capteur d'un instrument de pesage constitue, sans bien sûr en être une condition ni nécessaire, ni suffisante, une sérieuse indication du fait que l'instrument tout entier satisfera à la Recommandation OIML R 76 ou aux autres Recommandations OIML sur les instruments de pesage à fonctionnement automatique.

Les erreurs maximales tolérées (emt) sur la cellule de pesée sont égales à 0,7 fois l'emt de l'instrument complet et les 0,3 restant sont alloués aux erreurs mécaniques propres à l'instrument et aux erreurs d'indication.

Les constructeurs auront donc intérêt à produire ou à choisir des cellules de pesée certifiées conformes à OIML R 60.

Un certain nombre d'États Membres de l'OIML ont déjà désigné des autorités nationales de délivrance de certificats OIML pour les cellules de pesée: Danemark, France, Pays-Bas, Royaume-Uni et Suisse, à l'heure où nous publions ce Bulletin et les premiers certificats OIML sont attendus dans un avenir proche. ■





METROLOGY DAYS

For the bicentennial of the *Conservatoire National des Arts et Métiers (CNAM)*, two days for metrology have been organized by the National Metrology Institute, CNAM and the *Bureau National de Métrologie (BNM)*. The subjects to be addressed are "Heat, temperature, radiation" and "The meter and light" at the CNAM 4 May and 15 September 1994 respectively.

The most recent technical developments in temperature and length measurements will be presented during these two days which will be chaired by T. J. Quinn, Director of BIPM (4 May), and P. Giacomo, Honorary Director of BIPM and President of the Scientific Council of BNM (15 September).

Contact information:

INM-CNAM
292, rue St Martin
75003 Paris France
Tel: 33 (1) 40 27 21 55
Fax: 33 (1) 42 71 37 36

ASPECTS OF METROLOGY IN RUSSIA

L. K. Issaev, Vice-President, Gosstandart of Russia

In addition to my article published in the OIML Bulletin (Vol. XXXV, No. 1, January 1994, pp. 39–42) I would like to develop some ideas announced during the last OIML Development Council Meeting and the 28th Meeting of CIML in Berlin, October 1993.

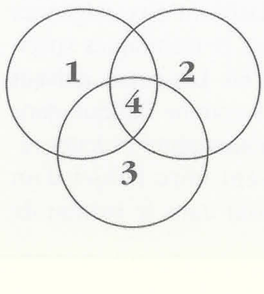
In Russia we have our National Measurement System, which was described in the abovementioned article. But we are also trying to gather together all participants involved with measurement activities including research and development people, manufacturers, metrologists, and users of measurement results. The primary aim of the Russian Measurement System (RMS) is to contribute to the economical and social development of the community, keeping in mind the Constitution, Laws, and Governmental Directives.

The main task of RMS is to realize a united technical policy for protecting the community from the negative consequences of incorrect measurement results. The strategy of RMS is the traceability of all meaningful measurement results, i.e. measurement uniformity. For that, we use legislative, executive, and supervisory metrological functions.

As an illustration of RMS we may expose the intersection of 3 circles as shown below: (1) Measurement Technique, (2) Users of Measurements, (3) Metrology. Examples of activities to be found in this scheme include the following.

Type (pattern) approval in the region where circles 1 and 3 intersect; verification and calibration in the region where circles 2 and 3 intersect; and instrument repair and service in the section where circles 1 and 2 intersect. The most interesting part of this diagram is region 4 - the common section for all three circles - which is the place (in our case) for Measurement Uniformity Assurance which includes legal metrology rules and regulations. This is the most important part from the governmental point of view.

This scheme is further explained in my article "The Russian Measurement System" in the magazine, Izmeritelnaya Tekhnika, No. 11, 1993 (in Russian), which will be published in English in Measurement Technique, Vol. 36, No. 4, 1994 by Plenum Publishing House (New York, USA).



EAST-WEST COOPERATION

After a joint communiqué on cooperation in conformity assessment issued by USA Vice-President Al Gore, Jr., and Russian Prime Minister Viktor Chernomyrdin, an international laboratory accreditation program is to be established by the end of 1994 to develop mutual recognition agreements for acceptance of test data for product certification.

The US National Institute of Standards and Technology (NIST) and the State Committee of the Russian Federation for Standardization, Metrology and Certification (GOSSTANDART) are working on the procedures for the program through which US manufacturers and exporters can obtain product test results that comply with Russian certification requirements and GOSSTANDART officials can accept test results from US laboratories accredited under the International Laboratory Accreditation Program (INTERLAP).

Contact information:

Lawrence Galowin
NIST
NVLAP, A162 TRF Bldg.
Gaithersburg, Md. 20899-0001
Tel: 19 (301) 975-4016

NEW PUBLICATIONS / *NOUVELLES PUBLICATIONS*

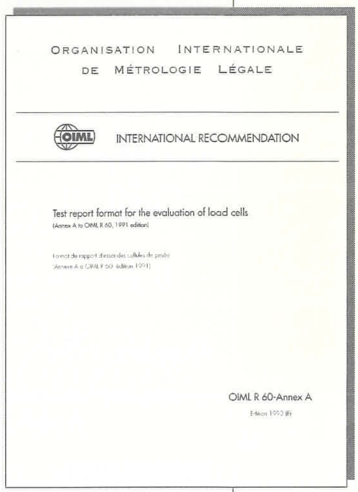
R 109 Pressure gauges and vacuum gauges with elastic sensing element (standard instruments)
Manomètres et vacuomètres à élément récepteur élastique (instruments étalons)

R 60 Annex A: Test report format for the evaluation of load cells
Annexe A: Format du rapport d'essai des cellules de pesée

These publications are available in French and English (see center section of the OIML Bulletin for price-list).

Ces publications sont disponibles en langues française et anglaise (voir prix dans le cahier central du Bulletin OIML).

To order a publication, please contact BIML / *Pour commander une publication, contactez le BIML:*
11, rue Turgot • 75009 Paris • France • Fax: 33 1 42 82 17 27


ORGANISATION INTERNATIONALE
DE MÉTROLOGIE LÉGALE

INTERNATIONAL RECOMMENDATION

Test report format for the evaluation of load cells
(Annex A to OIML R 60, 1991 edition)

OIML R 60-Annex A

Quick reference to standards

The KWIC INDEX of international standards, Sixth edition, 1993 can be obtained from ISO and IEC national members or from the ISO Central Secretariat and IEC Central Office.

This index includes some 15700 documents from ISO, IEC, OIML and 25 other international organizations.

Contact information:

ISO Central Secretariat
1, rue de Varembé
Case postale 56
CH-1211 Geneva 20
Tel: 41 22 749 01 11
Fax: 41 22 733 34 30

IEC Central Office
3, rue de Varembé
Case postale 131
CH-1211 Geneva 20
Tel: 41 22 734 01 50
Fax: 41 22 733 38 43

CIML

OIML extends a warm welcome to its new CIML Members:

Mr Ho Chang Guk
Dem. P. Rep. of Korea

Mr Ma Kyu-When
Rep. of Korea

Mr Krzysztaf Mordzinski
Poland

Dedicated to the 130th anniversary of the introduction of the metric system in Romania

5th National Symposium of Metrology

5–6 May 1994
Bucharest

This Symposium will address subjects including: measurement standards, industrial metrology, metrology and quality, legal metrology, measurement theory, measuring instruments, international cooperation in metrology.

OIML will be represented by the participation of a BIML staff member in this Symposium.

Contact information:

National Institute of Metrology
Sos. Vitan-Barzesti 11
75669 Bucharest 4
Romania

Bibliography

Green book: Quantities, units and symbols in physical chemistry (2nd edition) – IUPAC Chemical Data Series, 176 pp., £14.95, ISBN 0 632035838 (1993)

Metres to microwaves – E. B. Callick, 240 pp., £45, ISBN 0 86341 212 2 (1990)

Temperature measurement and control – J. R. Leigh, 208 pp., £44, ISBN 0 86341 111 8 (1988)

The finite element method in electromagnetics – Jianming Kin, 442 pp., £62, ISBN 0 471 58627 7 (1993)

Loadcell accuracy in process weighing - a confusion of terms
P. Zecchin, (Nobel Syst. Ltd., Bedford, UK) Sens. Rev. (UK), vol. 13, no. 3, pp. 9-12 (1993).

Instrumentation for engineering measurements (2nd edition)
J. W. Dally, W. F. Riley and K. G. McConnell, 584 pp., £18.95, (pbk) ISBN 0 471 6004 0 (1993)

This is a selected list of books or other documents of potential interest to Bulletin readers and is not to be considered as exhaustive.

It is with deepest regret that we announce the passing away of

Peter Clifford

on 9 January 1994.

Mr Clifford's dedication to standardization and metrology was reflected in his essential role in the activity of ISO/TAG 4 as the convener of the working group that produced the VIM. He also worked in electrical standardization at national (UK) and international (IEC) levels. Mr Clifford's death is a great loss to his many friends all over the world and in particular within the OIML community.

meetings

OIML

réunions

May 1994

13–20 TC 13/WG 1 and WG 2 — BRAUNSCHWEIG
Sound level meters and Audiometers

30–31 TC 9 — TEDDINGTON
Instruments for measuring mass and density

May–June 1994

31–3 TC 9/SC 2 — TEDDINGTON
Automatic weighing instruments

October 1994

10–11 Development Council Meeting — PARIS

12–14 29th CIML Meeting — PARIS

November 1994

12 TC 13 — LONDON
Measuring instruments for acoustics and vibration

OTHER MEETINGS

May 1994

17–18 Weighing, Calibration and Quality Standards in the 1990's — SHEFFIELD
Contact information:
I D Palmer, Standards Engineer, South Yorkshire Trading Standards Unit, Thorncliffe Lane, Chapeltown, Sheffield, South Yorkshire S 30 4XX
Tel: 44 742 46 34 91, Fax: 44 742 40 25 36

June 1994

13–16 Mid 90s Conference on Flow Measurement — GLASGOW
Contact information:
Mrs Liz Maclean, Conference Coordinator
NEL Flow Centre, East Kilbride, Glasgow G75 0QU, UK
Tel: 03552 72843 or 72448, Fax: 03552 72536

September 1994

5–9 13th IMEKO World Congress — TORINO
Contact information:
Ms Silvia Carradori and Ms Martina Giordano
Lingotto Centro Congressi, COREP, Via Nizza, 250–10126 Torino, Italy

October 1994

17–21 International Laboratory Accreditation Conference (ILAC) — HONG KONG
Contact information:
ILAC Secretariat
36th Floor, Immigration Tower, 7 Gloucerter Road, Wanchaï - Hong Kong, Fax: (19) 852 824 1302

info

The OIML Bulletin is pleased to introduce a new metrology journal, OFMET Info, issued by the Swiss Federal Office of Metrology (OFMET). Below is a condensed version of the Editorial from the first issue of the journal.

Dear Reader,

We are pleased to present to you our new periodical OFMET Info. From now on you will be informed in three to four issues a year on work performed at the OFMET, Switzerland's National Metrology Institute.

In today's society, economy and industry, a systematic information on metrology, the science of measurement; is obviously of great significance.

With this journal, we wish to address all our customers in the broad sense of the word. This includes, in the area of measuring instruments subject to verification (metrology surveillance, legal metrology), the responsible authorities and verifications in the cantons, and the verification laboratories authorised by the Federal department of Justice and Police as well as the instrument manufacturers themselves and their resellers.

Finally, we are communicating on our metrology work with our foreign partners and to international organisations with closer relation to metrology.

We are pleased that in the future our new journal OFMETInfo will allow us to report on our work and activities in such a fascinating science and technique like metrology.

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International vocabulary of basic and general terms in metrology (bilingual French-English)
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Metrology training - Synthesis and bibliography (bilingual French-English)
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Métrologie dans les Etats Membres et Pays Membres Correspondants de l'OIML

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Guidelines for the establishment of simplified metrology regulations

P 17 1993 300 FRF
Guide to the expression of uncertainty in measurement

II MEASUREMENT STANDARDS AND VERIFICATION EQUIPMENT
ÉTALONS ET EQUIPEMENT DE VERIFICATION

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Documentation for measurement standards and calibration devices
Documentation pour les étalons et les dispositifs d'étalonnage

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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
Equipement 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

III 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 1994 100 FRF
Continuous totalizing automatic weighing instruments
Instruments de pesage totalisateurs continus à fonctionnement automatique

R 51 1985 80 FRF
Checkweighing and weight grading machines
Trieuses pondérales de contrôle et trieuses pondérales de classement

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
1993 80 FRF
Annex A: Test report format for the evaluation of load cells
Annexe A: Format du rapport d'essai des cellules de pesée

R 61 1985 80 FRF
Automatic gravimetric filling machines
Doseuses pondérales à fonctionnement automatique

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

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

R 106 1993 100 FRF
Automatic rail-weighbridges
Ponts-bascules ferroviaires à fonctionnement automatique

R 107 1993 100 FRF
Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers)
Instruments de pesage totalisateurs discontinus à fonctionnement automatique (peseuses totalisatrices à trémie)

R 111 (being printed - en cours de publication)
Weights of accuracy classes E_1, E_2, F_1, F_2, M_1, M_2, M_3
Poids des classes de précision 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 weigh-bridges (bilingual French-English)
Equipement mobile pour la vérification des ponts-bascules routiers (bilingue français-anglais)

P 8 1987 100 FRF
Density measurement
Mesure de la masse volumique

IV 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

V 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 5 1981 60 FRF
Meters for liquids other than water with measuring chambers
Compteurs de liquides autres que l'eau à chambres mesureuses

R 27 1979 - 1973 50 FRF
Volume meters for liquids other than water. Ancillary equipment
Compteurs de volume de liquides autres que l'eau. Dispositifs complémentaires

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 (in revision - en cours de révision)
Water meters intended for the metering of cold water
Compteurs d'eau destinés au mesurage de l'eau froide

R 57 1982 80 FRF
Measuring assemblies for liquids other than water fitted with volume meters. General provisions
Ensembles de mesurage de liquides autres que l'eau équipés de compteurs de volumes. Dispositions générales

R 63 (being printed - en cours de publication)
Petroleum measurement tables
Tables de mesure du pétrole

R 67 1985 50 FRF
Measuring assemblies for liquids other than water fitted with volume meters. Metrological controls
Ensembles de mesurage de liquides autres que l'eau équipés de compteurs de volumes. Contrôles métrologiques

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 77 1989 60 FRF
Measuring assemblies for liquids other than water fitted with volume meters. Provisions specific to particular assemblies
Ensembles de mesurage de liquides autres que l'eau équipés de compteurs de volumes. Dispositions particulières relatives à certains ensembles

R 80 1989 100 FRF
Road and rail tankers
Camions et wagons-citernes

R 81 1989 80 FRF
Measuring devices and measuring systems for cryogenic liquids (including tables of density for liquid argon, helium, hydrogen, nitrogen and oxygen)
Dispositifs et systèmes de mesure de liquides cryogéniques (comprend tables de masse volumique pour argon, hélium, hydrogène, azote et oxygène liquides)

R 85 1989 80 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

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
Evaluation des étalons de débitmétrie et des dispositifs utilisés pour l'essai des compteurs d'eau

VI GAS MEASUREMENT
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 1989 80 FRF
Diaphragm gas meters
Compteurs de volume 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

VII PRESSURE
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 1991 80 FRF
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)

(*) See also medical instruments - *Voir aussi instruments médicaux.*

R 109 1993 60 FRF

Pressure gauges and vacuum gauges with elastic sensing elements (standard instruments)
Manomètres et vacuomètres à élément récepteur élastique (instruments étalons)

R 110 (being printed - en cours de publication)

Pressure balances
Manomètres à piston

VIII TEMPERATURE
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

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)

P 16 1991 100 FRF

Guide to practical temperature measurements

IX ELECTRICITY
ÉLECTRICITÉ

R 46 1980 - 1978 80 FRF

Active electrical energy meters for direct connection of class 2
Compteurs d'énergie électrique active à branchement direct de la classe 2

D 11 (in revision - en cours de révision)

General requirements for electronic measuring instruments
Exigences générales pour les instruments de mesure électroniques

X ACOUSTICS AND VIBRATION
ACCOUSTIQUE ET VIBRATIONS

R 58 1984 50 FRF

Sound level meters
Sonomètres

R 88 1989 50 FRF

Integrating-averaging sound level meters
Sonomètres intégrateurs-moyenneurs

R 102 1992 50 FRF

Sound calibrators
Calibreurs acoustiques

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

XI 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 1991 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 (being printed - en cours de publication)

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 (being printed - en cours de publication)

Portable gas chromatographs for field measurements of hazardous chemical pollutants
Chromatographes en phase gazeuse portatifs pour la mesure sur site des polluants chimiques 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

(*) See also medical instruments - *Voir aussi instruments médicaux.*

XII PHYSICO-CHEMICAL MEASUREMENTS
MESURES PHYSICO-CHIMIQUES

R 14 (in revision - en cours de révision)
Polarimetric saccharimeters
Saccharimètres polarimétriques

R 54 (in revision - en cours de révision)
pH scale for aqueous solutions
Echelle 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

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

XIII 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
Electroencéphalographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 90 1990 80 FRF
Electrocardiographs - Metrological characteristics - Methods and equipment for verification
Electrocardiographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 93 1990 60 FRF
Focimeters
Frontofocomètres

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

XIV 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

XV PREPACKAGING
PRÉEMBALLAGES

R 79 1989 50 FRF
Information on package labels
Etiquetage des préemballages

R 87 1989 50 FRF
Net content in packages
Contenu net des préemballages

OIML BULLETIN

CALL FOR PAPERS

The Editors of the OIML Bulletin welcome the submission of technical papers and articles that address new advances in Metrology, particularly in the fields of Trade, Health, Environment, and Safety in which the credibility of measurements remains a challenging priority.

Metrology is adapting to the changes that are rapidly occuring worldwide and the OIML Bulletin strives to reflect this adaptation. National, regional, and international activities concerning evaluation procedures, accreditation and certification, measuring techniques and instrumentation, and implementation of OIML Recommendations as well as other international publications relative to metrology are of interest to the expanding audience of the OIML Bulletin.

In addition to a manuscript and visual materials (photos, illustrations, slides, etc.), a disk copy of the submission should be included whenever possible (floppy disk or 3 1/2" microdisks – Wordperfect/DOS or other compatible software). Authors are also encouraged to send a passport-size photo for publication. Selected papers will be remunerated at the rate of 150 FRF per printed page, provided that they have not been previously published. The Editors of the OIML Bulletin reserve the right to edit contributions for style and space restrictions.

Papers should be sent to the *Bureau International de Métrologie Légale,* Attn. Editors of the OIML Bulletin, 11, rue Turgot, 75009 Paris France.