

# OIML

# BULLETIN

SEPTEMBER/DECEMBER 1993 NUMBERS 132/133

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

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QUARTERLY JOURNAL

**MEASUREMENT CREDIBILITY**

*Environment*

*Health*

*Trade*

*Safety*





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JOURNAL OF THE ORGANISATION  
INTERNATIONALE DE MÉTROLOGIE LÉGALE.

The Organisation Internationale de Métrologie Légale (OIML), established 12 October 1955, is an inter-governmental 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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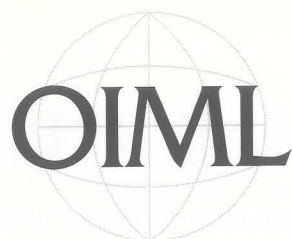
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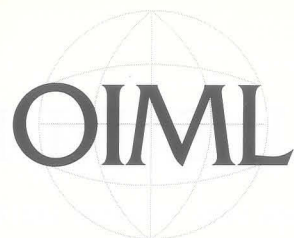
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OIML INCREASES ITS  
GLOBAL PRESENCE

VENTURING INTO  
NEW SPHERES OF  
ENVIRONMENT,  
HEALTH, SAFETY,  
AND TRADE.

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# Editorial

**Bernard Athané**

Director, Bureau International de Métrologie Légale

Le "Bulletin nouveau" est arrivé. Quelques semaines avant que le "Beaujolais nouveau" n'envahisse le monde entier, l'Organisation Internationale de Métrologie Légale a le plaisir de vous présenter son nouveau Bulletin. Mais, contrairement au fameux vin français qui revient chaque année, nous saurons faire en sorte que le nouveau Bulletin OIML se maintienne pendant de nombreuses années.

La métrologie légale vit une période de mutation. Le besoin d'une crédibilité toujours plus grande des résultats de mesure apparaît dans de nombreux domaines liés à la protection du consommateur, au contrôle de l'environnement, à la santé ou à la sécurité. Par ailleurs, les structures classiques de métrologie légale connaissent des évolutions liées aux processus d'accréditation des laboratoires et de certification des produits. Enfin, la régionalisation de nombreuses activités à caractère réglementaire se développe.

Face à ces changements, l'OIML se devait de réagir pour renforcer son influence mondiale et accélérer son rôle harmonisateur. C'est ainsi qu'une restructuration de nos organes techniques et une redéfinition de nos responsabilités, rendant prioritaires les travaux sur les instruments de mesure utilisés dans les domaines du commerce, de la santé, de l'environnement et de la sécurité, ont été réalisées. Nous développons également notre stratégie de communication pour accroître l'audience de l'Organisation.

Un des outils de communication de l'OIML est constitué par son Bulletin. Autour de Philippe Degavre et Kristine French, Editeurs du Bulletin OIML, une équipe a consacré beaucoup de réflexions aux changements de forme et de fond pour rendre le Bulletin plus utile et attractif.

Voici donc ce nouveau Bulletin OIML. A vous maintenant, Lecteurs, de réagir. Faites-nous connaître vos critiques, elles nous seront utiles pour améliorer encore ce journal. Et si vos réactions sont favorables, cela ne pourra que nous encourager à poursuivre dans la bonne direction!

The "new Bulletin" has arrived. Some weeks before the "new Beaujolais" invades all corners of the world, the Organisation Internationale de Métrologie Légale has the pleasure of presenting its new journal. However, contrary to the famous French wine that makes a new appearance each year, we will ensure that the new Bulletin endures for many years to come.

Legal metrology is undergoing many changes. The need for an ever-increasing credibility in measurement results is evident in many areas of consumer protection, environmental control, health, and safety. The classical structures of legal metrology are evolving as the accreditation of laboratories and product certification become more important. Moreover, the regionalization of many regulatory activities is rapidly developing.

OIML recognizes the importance of reacting to these changes in order to re-enforce its global influence and to accelerate its pursuit of harmonization. We have therefore restructured our technical bodies and redefined our responsibilities. Priority has been given to activities linked to measuring instruments used in the fields of trade, health, environment, and safety. We are also developing our communication strategies and expanding the audience of our Organization.

One of OIML's tools for communicating is its Bulletin. In cooperation with Philippe Degavre and Kristine French, Editors of the OIML Bulletin, a team has given much reflection to changes in form and content so as to render the publication more useful and attractive.

Here is the new OIML Bulletin. Now it's up to you, Readers, to react. Your critiques will be useful to us in further improving this journal; and if your reactions are positive, they will only encourage us to continue in the right direction!

A handwritten signature in dark ink, appearing to read 'B. Athané'.







## Measuring instruments in medicine

### NON-INVASIVE SPHYGMOMANOMETERS: A REVIEW AND OUTLOOK

**STEPHAN MIEKE AND ULRICH EICKELKAMP**

Physikalisch-Technische Bundesanstalt, Germany



**T**HE technique of automated non-invasive blood pressure measurement has been improved considerably in the past 15 years. Critical points for the design and testing of the devices are discussed from the point of view of the PTB Laboratory.

#### Blood pressure measurements: performance checking in Germany

Worldwide, the indirect blood pressure measurement is one of the standard examinations in the medical check-up. Due to the increasing number of hypertensive diseases in most industrialized countries in the last 20 years [1], the non-invasive blood pressure measurement has become even more important. About 20 % of the German adult population is suffering from hypertension, a major reason for cardiovascular diseases.

In Germany, the performance of non-invasive sphygmomanometers is controlled and tested by pattern approval which is carried out by PTB and the verification of every device is performed by national verification offices (more than 100 in Germany).

#### The most important methods of measurement

The most common methods for the non-invasive blood pressure measurement (auscultatory and

oscillometric method) are based on the occluding cuff developed by Riva-Rocci in 1895.

The auscultatory method was established in 1905 by Korotkov, who noticed that the appearing and disappearing of sound generated in the artery of the upper arm (arteria brachialis) was an indication of the systolic and diastolic blood pressure values.

The existence of pressure oscillations in the cuff were observed very soon after the development of the cuff. But it was not until 1969 that Geddes and co-workers [2,3,4] published fundamental ideas on how to calculate blood pressure values from the envelope of the pressure oscillation amplitudes.

#### Historical background

In 1951, the PTR (which is the predecessor of the PTB) tested about 300 non-invasive sphygmomanometers (with mercury and aneroid manometers) used in hospitals in Berlin [5]. Almost half of them were classified as unacceptable for further use, 34 % had to be re-adjusted, and 13 % had to be repaired. Consequently, harmonized requirements between East and West Germany were specified in 1952 [6], but these requirements were not yet part of the mandatory regulations. Similar requirements also existed at that time in Austria and in the USA.

Although requirements for non-invasive sphygmomanometers became part of the verification ordinance [7] in 1956, obligatory verification was introduced in 1970 in the Federal Republic of Germany. Since 1961, verification had been mandatory for non-invasive sphygmomanometers in the German Democratic Republic.

During the past 20 years, the number of non-invasive sphygmomanometers has increased remarkably. Some of the main reasons for this increase:

- Since the mid-seventies, a growing number of home blood pressure monitors have been sold

because national and international medical committees and societies have informed the public about the existence of high blood pressure and have recommended home monitoring.

- Since the beginning of the eighties, blood pressure monitors have been specially designed for the clinical area in order to relieve the medical staff from routine measurements by automated monitoring and to substitute invasive measurements in certain areas.
- Since the mid-eighties, there has been attention to the design of special blood pressure monitors, e.g. monitors for measurements in ambulance cars, portable instruments for ambulatory measurements over 24 hours in certain intervals, instruments for measurement during physical exercise, monitors for neonates, etc.

## Home use of blood pressure monitors

Following clinical thermometers, non-invasive sphygmomanometers are the highest selling medical devices sold to private homes in Germany. More than 500 000 are sold every year and sales are still increasing.

Modern blood pressure monitors are in most cases characterized by the oscillometric method. Ap-

proximately 80 % of the monitors for home use sold in Germany are made in Japan and about 4 million monitors are manufactured every year in Japan.

The price of such monitors, which starts at ca. DM 100 (ca. \$65) due to high competition on the market, indicates that the costs are calculated to their extreme. Reductions in costs are often possible only by saving parts or using cheaper components. As inexpensive components usually have a lower quality, the performance may be affected. After modifications in production lines, the PTB found the quality of pressure transducers to be unacceptable. Saving valves in the pneumatic system may reduce the performance as well. Both modifications result in measurement errors that cannot be recognized by the user.

Monitors intended for home use must be designed in such a way that ordinary people may be able to handle them correctly. Wrong handling is often the cause of incorrect results. Since the deflation rate directly influences the accuracy of the measurement, proper adjustment of the deflation valve is extremely important. The optimal rate is 2-3 mmHg/s. With standard valves, the optimal range can be maintained only by re-adjustment during the course of the measurement. People with limited training are usually not able to do these re-adjustments. The development of self-linearizing mechanical valves (Fig. 1) and the

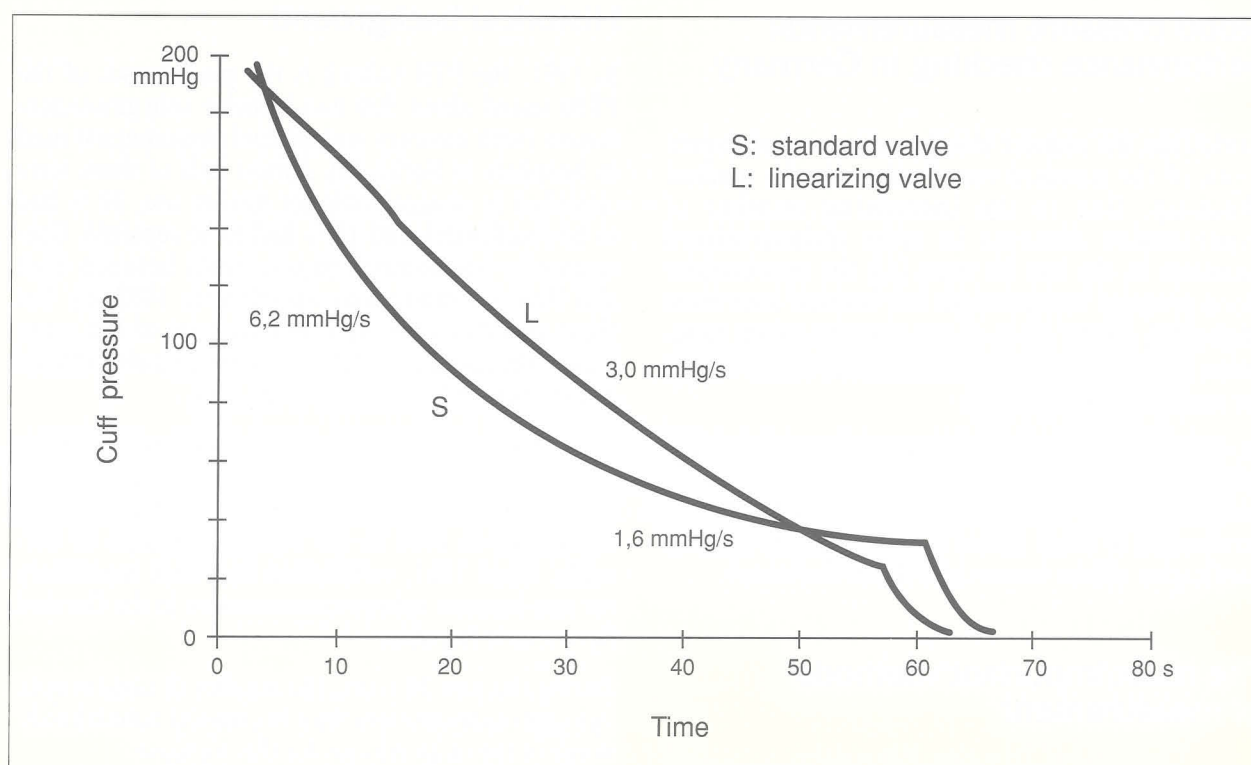


Fig. 1 Curves of the pressure reduction for two different deflation valves; cuff applied at the upper arm



PTB policy of only approving these valves for home use monitors lead to better performance and easier handling of the device.

Costs can be reduced not only in hardware but also in software. In the beginning, PTB tested oscillographic monitors that were very sensitive due to muscle tension or arm movements, therefore giving erroneous readings. This effect was related to poor software that did not include artifact rejection or handling algorithms. It took two years before improved monitors were available and able to receive PTB approval.

Consumer tests in France [8] and the Netherlands [9] classified the monitors that were rejected by the PTB as 'poor'. Monitors that were classified as 'good' were identical to the PTB approved ones. The last consumer test in Germany [10] (all monitors were approved by the PTB) graded no monitor 'poor'. Rumors that some manufacturers supply different markets with devices of different levels of quality seemed to be proven by these consumer tests.

Monitors that measure at the finger are rejected by PTB and are therefore not available on the German market. In 1990, the PTB performed a clinical trial which showed that the readings taken at the finger

were not identical to those taken at the upper arm due to physiological reasons. In support of this finding, a recent consumer test in the USA [11] classified all monitors measuring at the finger as 'not acceptable'.

## Monitors for clinical use

The requirements on automated non-invasive blood pressure monitors used in clinics are more detailed and include more points than those for home use monitors. The field of application ranges from the standard examination to the operation room and intensive care unit. Readings are taken on adults as well as on children or neonates, in rest or during physical stress.

Most of these monitors are equipped with additional modules for the measurement of other physiological parameters, such as body temperature, and oxygen saturation. Some monitors often consist of modular components (e.g. display, parameter modules, etc.) in separate housings (Fig. 2). Input/Output ports for the connection of printers or communication with central computers are almost standardized.

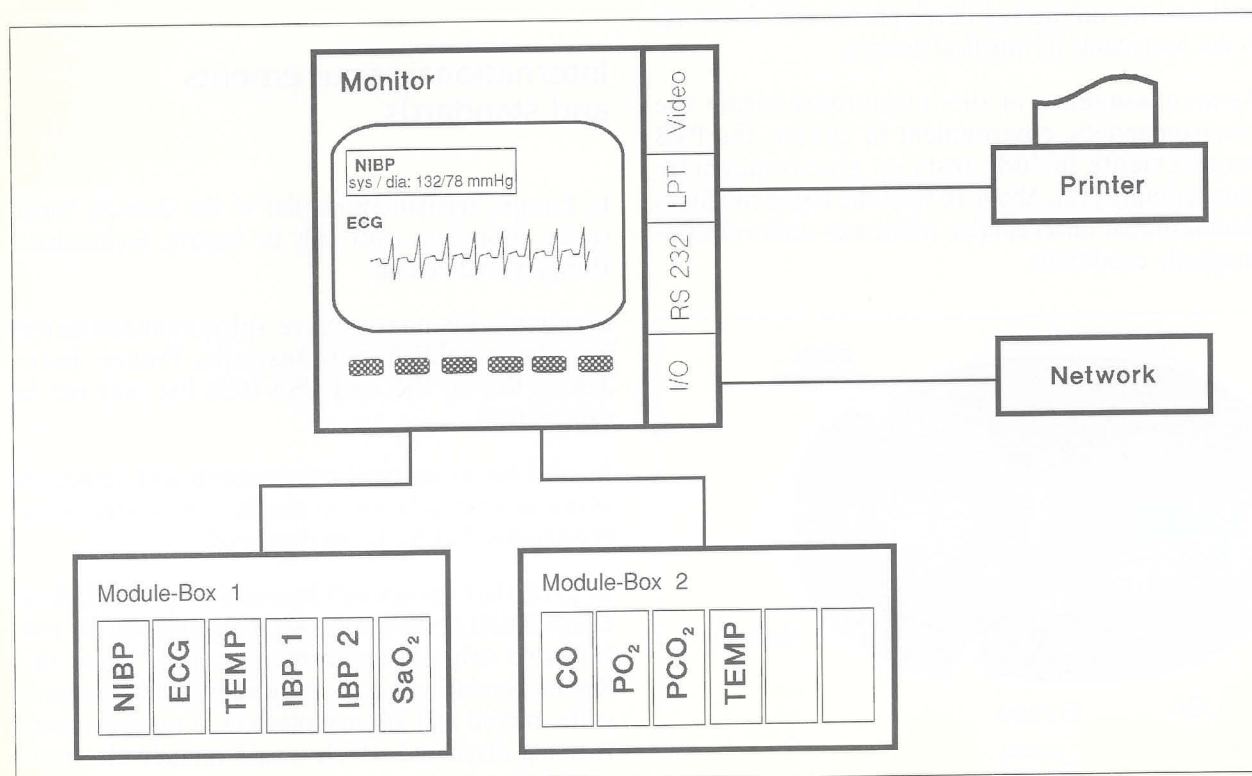


Fig. 2 Example of a modular monitor system with two external module boxes equipped with modules measuring different parameters (NIBP: non-invasive blood pressure, IBP: invasive blood pressure, TEMP: body temperature, ECG: electrocardiogram,  $\text{SaO}_2$ : oxygen saturation,  $\text{PO}_2$ : carbon dioxide partial pressure, CO: cardiac output)

In the clinical area, almost all non-invasive blood pressure monitors use the oscillometric method for the determination of blood pressure with the values, with the exception of ambulatory 24 hour monitors and devices that measure during physical stress, most of which use the auscultatory method.

The PTB approval for oscillometric devices focuses special attention on algorithm for the determination of the blood pressure values due to its importance for the performance. To shorten the measuring time, high deflation rates ( $> 3$  mmHg/s) are possible when certain preconditions are met. The essential points: to use undisturbed or corrected oscillations for the calculation of the blood pressure values and to incorporate interpolation and curve fitting programs. By doing so, the oscillometric monitors reach the same level of performance as the auscultatory ones. In the past, the algorithms of a number of oscillometric monitors had to be improved before they were accepted by the PTB, and in particular smoothing and curve fitting programs had to be added.

Other parts of the software, such as the calibration and auto-zeroing of the pressure transducer, are also very important for the performance. The experience of the PTB is that often, a re-design was necessary in order to obtain the PTB approval. A large number of software updates in a short period of time generally indicates an unfinished development and therefore, is not acceptable for medical devices.

As a consequence of the interferences from the electromagnetic environment in clinics, the PTB requirements include tests on electromagnetic compatibility [12]. About 10 % of the tested monitors demonstrated unacceptable influences under electromagnetic conditions.

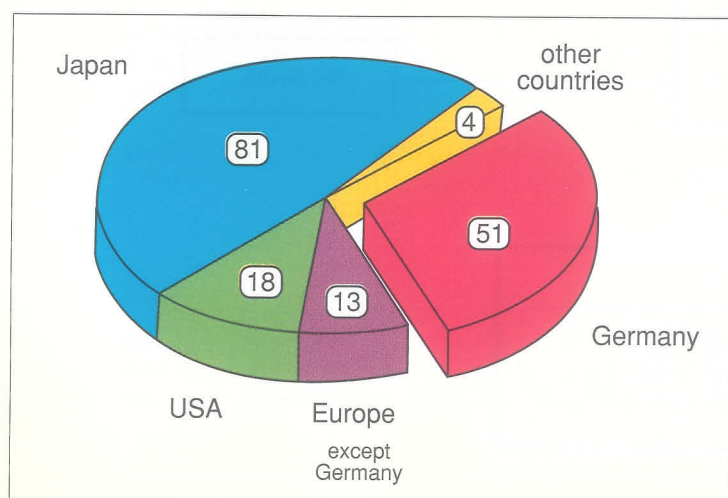


Fig. 3 Origin and number of non-invasive sphygmomanometers approved in the Federal Republic of Germany between 1980 and 1991

## Statistics

Between 1980 and 1991, 167 different non-invasive sphygmomanometers were approved by the PTB. Most of them were manufactured in Japan (Fig. 3). About one-third of the devices is made in Germany, mainly those with aneroid- or Hg-manometers for clinical areas. The Japanese products are made predominantly for home use, whereas those produced in the US are for clinical applications.

The total number of verifications since 1975, and the number of initial and subsequent verifications since 1980 are available. The number of verifications has increased remarkably in this period (Fig. 4 - see p. 9).

At least every two years, non-invasive sphygmomanometers must be re-verified in Germany and approximately 7-8 % are rejected. The finding of an investigation made by the verification office in Berlin in 1987 was that approximately one-third of the refused devices was rejected because such devices exceeded the maximum permissible errors of verification ( $\pm 4$  mmHg) and one-third due to leakage of the pneumatic system. The rejection rate at the initial verification is much lower: ca. 1 %.

## International requirements and standards

In Europe, regulations similar to the German Verification Ordinance exist only in Austria, Switzerland, Hungary, and Poland.

Standards for non-invasive sphygmomanometers have been published in Australia, France, India, Japan, Korea, UK, and USA (this list may not be exhaustive).

In addition to national requirements and standards, there are already some drafts for international regulations that are being discussed.

In 1970, the *Organisation Internationale de Métrologie Légale* (OIML) published a Recommendation for non-invasive sphygmomanometers [13]. Since this Recommendation covers only sphygmomanometers with aneroid and Hg manometers, a revised version is being discussed which would include electronic monitors.

The International Electrotechnical Commission (IEC) published general requirements for the safety



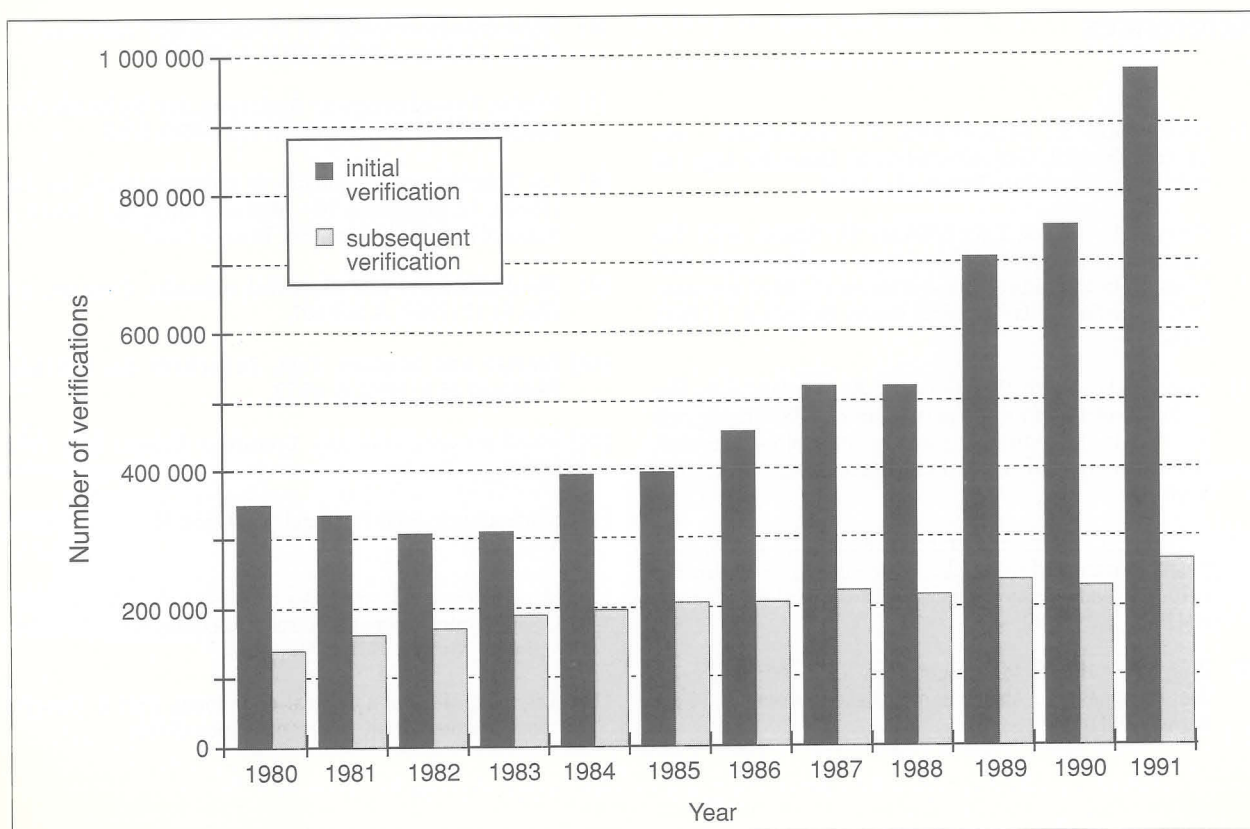


Fig. 4 Number of verification acts (initial and subsequent) of non-invasive sphygmomanometers in the Federal Republic of Germany between 1980 and 1991

of medical electrical equipment [14]. At present, a special IEC working group is preparing additional safety requirements for automatic non-invasive blood pressure monitors.

In 1991, a special working group was formed by the *Comité Européen de Normalisation (CEN)* to formulate requirements on the safety and the performance of non-invasive sphygmomanometers. The proposed standard is structured into four parts. The discussions for a final working draft for the first two parts (General requirements and Supplements for mechanical sphygmomanometers) were finished in Autumn 1992 and will be published as drafts in the near future. The other parts (Supplements for electro-mechanical blood pressure measuring systems and for electro-mechanical sphygmomanometers) should be published as drafts in 1993/1994.

## Towards quality and harmonization

Due to the poor performance of mechanical non-invasive sphygmomanometers, mandatory requirements have existed in Germany since 1970.

Up to the present, the PTB has approved more than 300 devices, one-quarter of which had to be re-designed to improve the performance.

In contrast to the low rejection rate at initial verification, the rejection rate at subsequent verification is 7-8 %. International comparisons confirm the higher level of quality on the German market due to the German regulations. Non-invasive sphygmomanometers which were rated 'poor' by independent test houses were not approved by the PTB. Some manufacturers give references to the PTB approval as a quality indication in their sales promotion outside Germany.

Throughout the world, an increasing number of requirements and standards for non-invasive sphygmomanometers are published. Although the different national requirements and standards aim for similar safety and performance levels, there are differences in the details. Consequently, manufacturers must produce specific versions for each market. However, efforts are being made to achieve international standards so as to reduce costs and harmonize requirements.

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## Principles and practice

### SWISS REFERENCE GASES FOR CHECKING EMISSION MEASURING INSTRUMENTS



**JEAN-FRANÇOIS PERROCHET** Swiss Federal Office of Metrology, Wabern, Switzerland

#### The need for reference gases

Measuring devices for exhaust gases of automotive petrol engines have been approved and certified officially in Switzerland since 1985. Since 1987, measuring devices for stack gases of small heating installations using light fuel and natural gas have also been certified. The adjustments, calibrations, and routine checks for all these devices require reference gases traceable to the national standard. Therefore, it has been necessary to set up

national standards at the Swiss Federal Office of Metrology (OFMET).

The conventional true values of the reference gases adopted as national standards are determined by mutual comparisons. The measurements for these comparisons are either *horizontal* (equal concentrations) or *vertical* (different concentrations in a mixture of gases). The main reasons for this choice, the realization of families (base) of standards at the OFMET, and some measurement results will be described.



Swiss Federal Office of Metrology, Wabern Switzerland

## Swiss standards for gas mixtures: arguments for the selection of a method and traceability

In principle, there are two ways to establish standards of gas mixtures:

- Preparing specified gas mixtures: for example, such mixtures are prepared with a very high degree of accuracy by the National Physical Laboratory, NPL (GB) [1] and the Nederlands Meetinstituut NMI (NL) [2] by using the gravimetric method [3,4].

- Using commercially available gas mixtures prepared by the gravimetric method, measuring the concentrations and then comparing them.

This second method has been chosen by the OFMET as a first approach for the following reasons:

- The OFMET is not in a position to invest the skilled manpower necessary for primary standards of high authority.
- The know-how and the facilities are available or prepared at three supplier's facilities situated some 30 to 150 km away from OFMET, including the gravimetric filling stations for cylinders. These

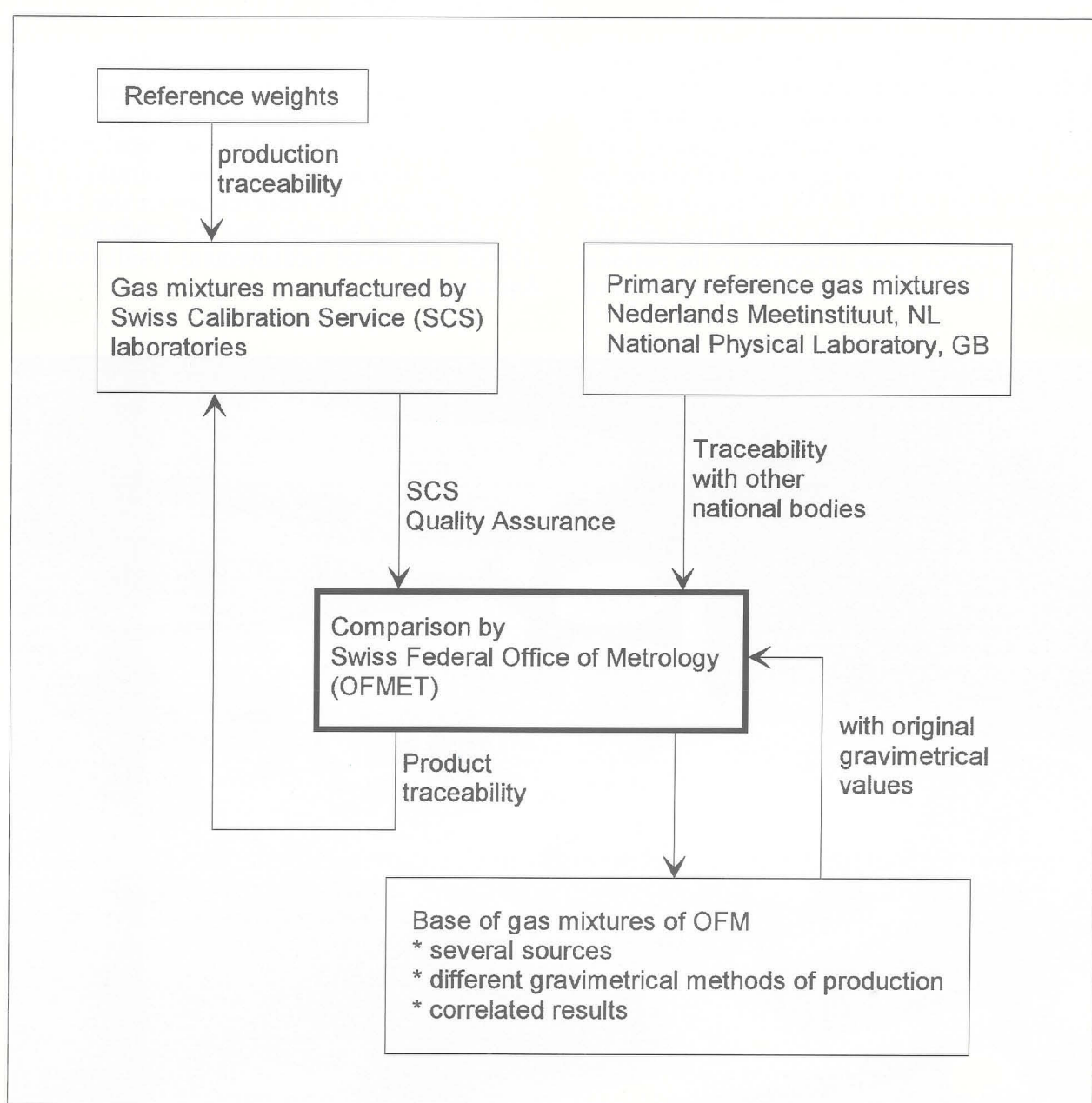


Fig. 1 Strategy for establishing the Swiss base of gas mixtures



suppliers are already able (or preparing) to supply gas mixtures offering an accuracy fairly sufficient for the initial needs of the users. In addition, the close collaboration of the OFMET with the suppliers continues to evoke multiple improvements that are valuable for both sides.

- There is always the possibility of switching to the gravimetric preparation of gas mixtures without any loss of know-how, since it is necessary to perform comparative measurements in order to maintain the metrological quality.
- It is easy to compare our standards with others by including some primary reference standards from other countries (e.g. from NMI, NL or NPL, GB) in the measuring procedures.

It is obvious that in this way we will not have families of standards of the same quality as primary reference standards; however, the target accuracy (0.5 % to 1 % rel for concentrations higher than 100 ppm) is met. The traceability is therefore assured in three complementary ways (Fig. 1).

- 1) The periodical calibration of the weighing machines used for filling the cylinders by using weights that are certified by the OFMET (traceability of preparation of gas mixtures).
- 2) *Horizontal* and *vertical* comparison of cylinders of different sources. When the measurements are achieved, some of the cylinders are kept at the OFMET (as national standards), the others are returned to the supplier for the traceability of the product and for quality assurance purposes related to the Swiss Calibration Service (SCS).
- 3) Primary reference standards for gas mixtures are included in our families and are used in the calibration procedures for our comparator system (international traceability obtained through comparison of our primary reference standards with those of other countries).

### Standards of gas mixtures certified by OFMET and national reference gas mixtures

At the time being, the national standards of the OFMET meet, to some extent, the requirements in the field of pollutant emission (see Table 1). We expect to add the nitrogen monoxide, NO, to the group of reference gases in 1993.

Table 1 Range covered by national standards of gas mixtures by OFMET

| Gas  | Concentration [% mol] | Uncertainty of OFMET certification ( $2\sigma$ ) |
|--|-----------------------|--|
| CO in N <sub>2</sub>                             | 0.003 - 5             | 0.0002 % mol - 0.5 % rel                         |
| CO <sub>2</sub> in N <sub>2</sub>                | 6 - 15                | 0.5 % rel  |
| O <sub>2</sub> in N <sub>2</sub>                 | 3 - 21                | 0.5 % rel  |
| C <sub>3</sub> H <sub>8</sub> in N <sub>2</sub>  | 0.01 - 0.4            | 1 - 0.5 % rel                                    |
| C <sub>6</sub> H <sub>14</sub> in N <sub>2</sub> | 0.005 - 0.2           | 2 - 1 % rel                                      |

### Instrumentation

Our measuring device consists of two parts:

- The computer-controlled pneumatic system (Fig. 2). A signal is provided in order to start a measuring cycle of the comparator, thus allowing an automatic run of one or more sets of measurements.
- The comparator which consists of a gas chromatograph and peripherals for data acquisition and processing.

### The measurement principle

The final result of any comparison between standards or the certification of mixtures is based on two or more independent sets of measurements; each set is measured on different days.

An independent set of measurements comprises two phases (Table 2):

- the data acquisition of information delivered directly by the comparator,
- the data processing: calibration based on the gravimetric true values (for the intercomparison of the national reference gases) or on the conventional true values (for certification) of the national standards, the subsequent calculation of concentrations for all gas mixtures (standards and gas mixtures to be certified).

Contrary to the procedure in classical chromatography, we do not follow the normal procedure of first performing a calibration cycle and then a measuring cycle. This is to avoid possible fluctuations of time dependent influence factors, such as temperature or air pressure.

Fig. 2 Distribution and flow control of gas mixtures

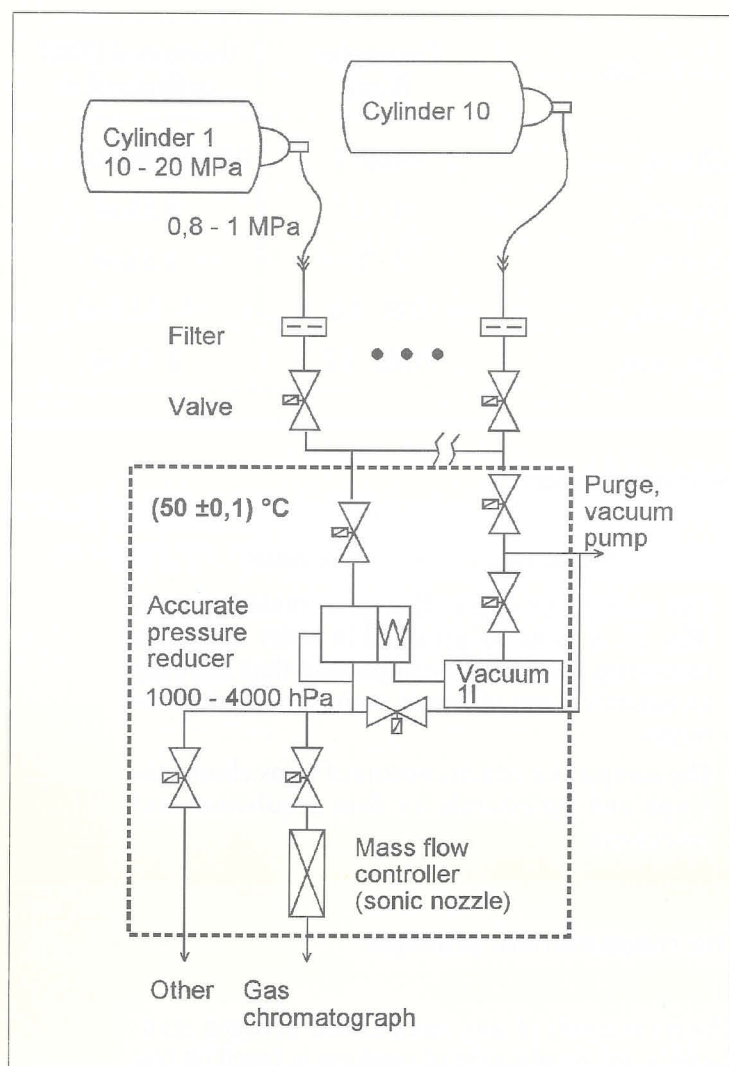


Table 2 Principle of one set of measurements

|  |  |   |
|--|--|---|
| <b>Data acquisition</b><br>Direct reading (arbitrary unit) | Gases with the same concentration<br>Order of measurement: mixtures 1, 2, 1, 3, 4...1, 4...1   | Gases with different concentrations<br>Order of measurement: from lowest to highest concentration |
| <b>Data processing</b><br>Post run                         | Optimization of integration parameters for chromatograms   |   |
| Calibration: Constant(s) of the instrument                 | 1. Constant for each standard<br>2. Mean of the constants  | Polynomial regression<br>$x_i$ = value of standard $i$<br>$y_i$ = direct reading of mixture $i$   |
| Results of a measurement                                   | For all mixtures, standards included:<br>• Calculated concentration<br>• Difference with the given value<br>• Quality assurance (standard deviation, range...) |   |

A final result is obtained with the following:

- At least two independent sets of measurements.
- Each set of measurements consists of at least one cycle of four direct and consecutive injections per gas mixture.
- During horizontal comparisons, several cycles are performed with the first cylinder, especially the first and last cycles. This is a check for the repeatability of the measurement set.
- When vertical comparisons are made, the cycles of injections of gas mixtures are executed in the order of increasing concentrations. This reduces the influence of the preceding charge to the actual charge (hang-up) to a minimum and a monotone drift of the comparator can be compensated by a polynomial regression.

The working principle of a chromatographic evaluation is the integration of a signal. This, together with data processing, opens the way to an interesting feature: it is indeed possible to optimize parameters for integration and calculation when the measurements are already made. Consequently, we re-integrate all chromatographic signals using two different methods and take advantage of an additional element of quality assurance.

It is necessary to adopt an adequate polynomial curve-fitting algorithm when a vertical comparison of standards is made. We chose a polynomial of degree 2 as the best suitable regression (Fig. 3) for the following reasons:

- A linear regression does not take into account the non linear effects of the integration methods.
- A polynomial with too high of a degree tends to hide the vertical character of the comparison. For example: a polynomial of degree 3 applied to 4 concentrations and 2 mixtures per concentration would give the same result as 4 independent horizontal comparisons!
- The uncertainty of the results is proportional to the concentration in the gas mixture as a first approximation. Every subsequent dilution increases the uncertainty by a factor of 2. The measured values (the integrated areas under the peaks in a chromatogram) used for the regression calculation are therefore weighted by a coefficient inversely proportional to the concentration and by a factor equal to 1 in the case of high concentrations and equal to 1/2 when the mixture is obtained with subsequent dilution in order to obtain low concentrations (Fig. 4).



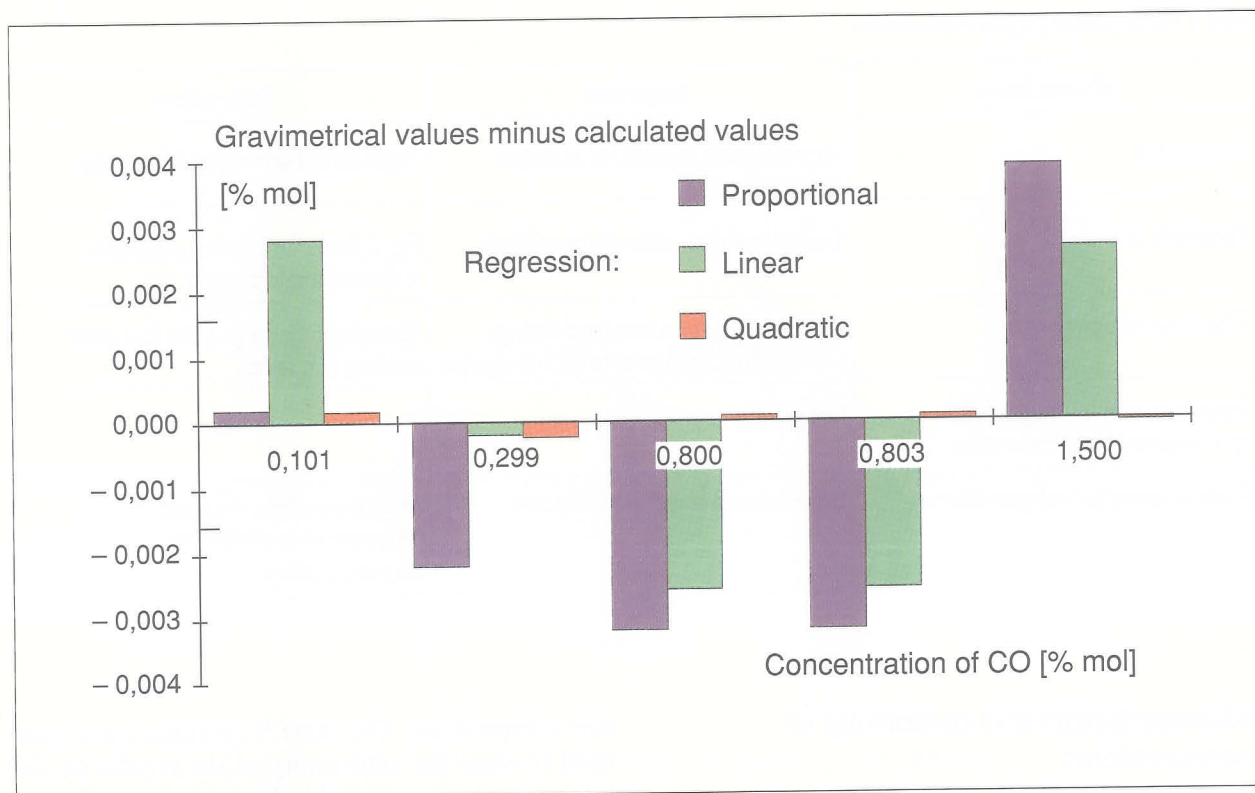


Fig. 3 Result of a vertical comparison of standards (CO 0,1 - 1,5 % mol) with different polynomial curve-fitting algorithms (regressions)

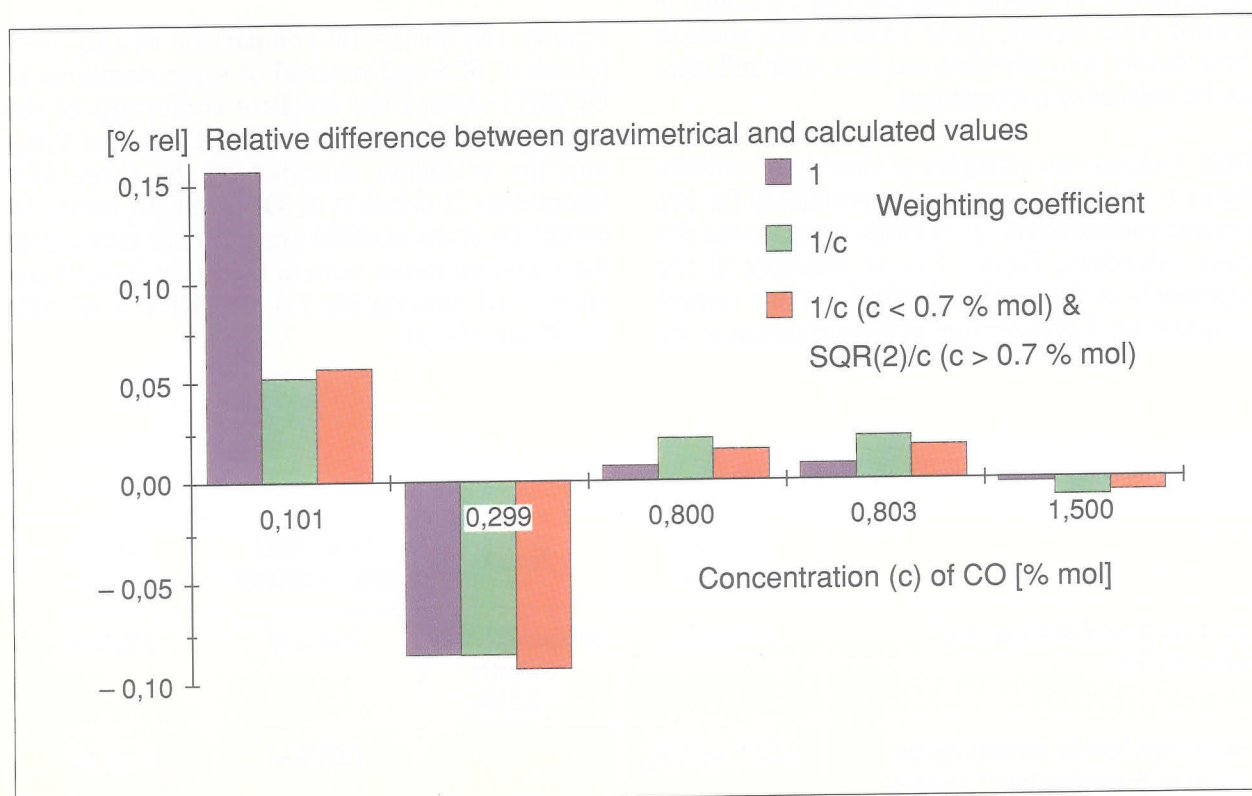


Fig. 4 Result of a vertical comparison of standards (CO 0,1 - 1,5 % mol) with polynomial of degree 2 with different weighting coefficients

Table 3 Factors influencing the measurement

| Influence factors   | Precautions   | Observations  |
|---|---|---|
| Temperature   | chromatograph in stabilized enclosure ( $\pm 0.1^\circ\text{C}$ )                         | Visual control with digital thermometer   |
| Barometric pressure   | Control (intended: automatic correction)  | Fig. 5 shows the influence of variation in the barometric pressure                    |
| Cleanliness of piping   | Repeated purges (vacuum) and rinsings<br>Constant flow 5 min prior to the first injection | Control with the range of the four direct readings of a series                        |
| Parameters of chromatograph (all gas pressures, oven, temperature...) | Optimization  |   |
| Purity of components of gas mixtures                                  | Gas mixture of several manufacturers  | At the present time, the purity of the components is controlled by the manufacturers. |

### Influence factors and conformity of measurements

The measurements are affected by several, sometimes unknown factors. The long and short-term stability of the results and the comparison of the standards are very useful indicators for the ability to control these factors. Table 3 shows how some of these factors are controlled and how their influence can be reduced or compensated.

Table 4 shows two examples of short-term stability. Figure 6 shows an example of repeatability for two vertical comparisons, 21 months apart, using the same cylinders. Figure 7 is an example of the conformity of the results obtained for two vertical comparisons; 3 cylinders out of 9 are common to the

two comparisons. The same 9 cylinders have been used to state the conformity of the results on the time scale, as represented in Figure 8: four cylinders were used in three vertical comparisons in 1988, 1989, and 1991; two were used in only two comparisons and the last three cylinders were measured in 1991.

Finally, the horizontal comparison of July 1992 (check of SCS and renewal of some standards at OFMET) showed the excellent conformity of the standards at OFMET (1 cylinder of 300 ppm  $\text{C}_3\text{H}_8$ ) and the cylinders supplied by the three SCS laboratories (2 cylinders of 300 ppm  $\text{C}_3\text{H}_8$  each): the deviations of the nominal gravimetric values from the measured values were in the range of -0,19 and +0,34 % rel (uncertainty,  $2\sigma$ : OFMET 1 % rel, SCS Certificate 2 % rel).

Table 4 Example of short-term repeatability of measurements

|   | Nominal or mean value             | Remark  | Experimental standard deviation | Maximum difference |
|---|-----------------------------------|---|---------------------------------|--------------------|
| 24 values (6 series of 4 injections) within 4 1/2 h   | 5 % mol $\text{O}_2$              | Barometric pressure constant to $\pm 0.5$ hPa | 0.05 % rel                      | 0.20 % rel         |
| 18 injections from the reference cylinder in a set of 39 injections from 7 cylinders (duration 5 h) | 0.03 % mol $\text{C}_3\text{H}_8$ | —   | 0.03 % rel                      | 0.12 % rel         |



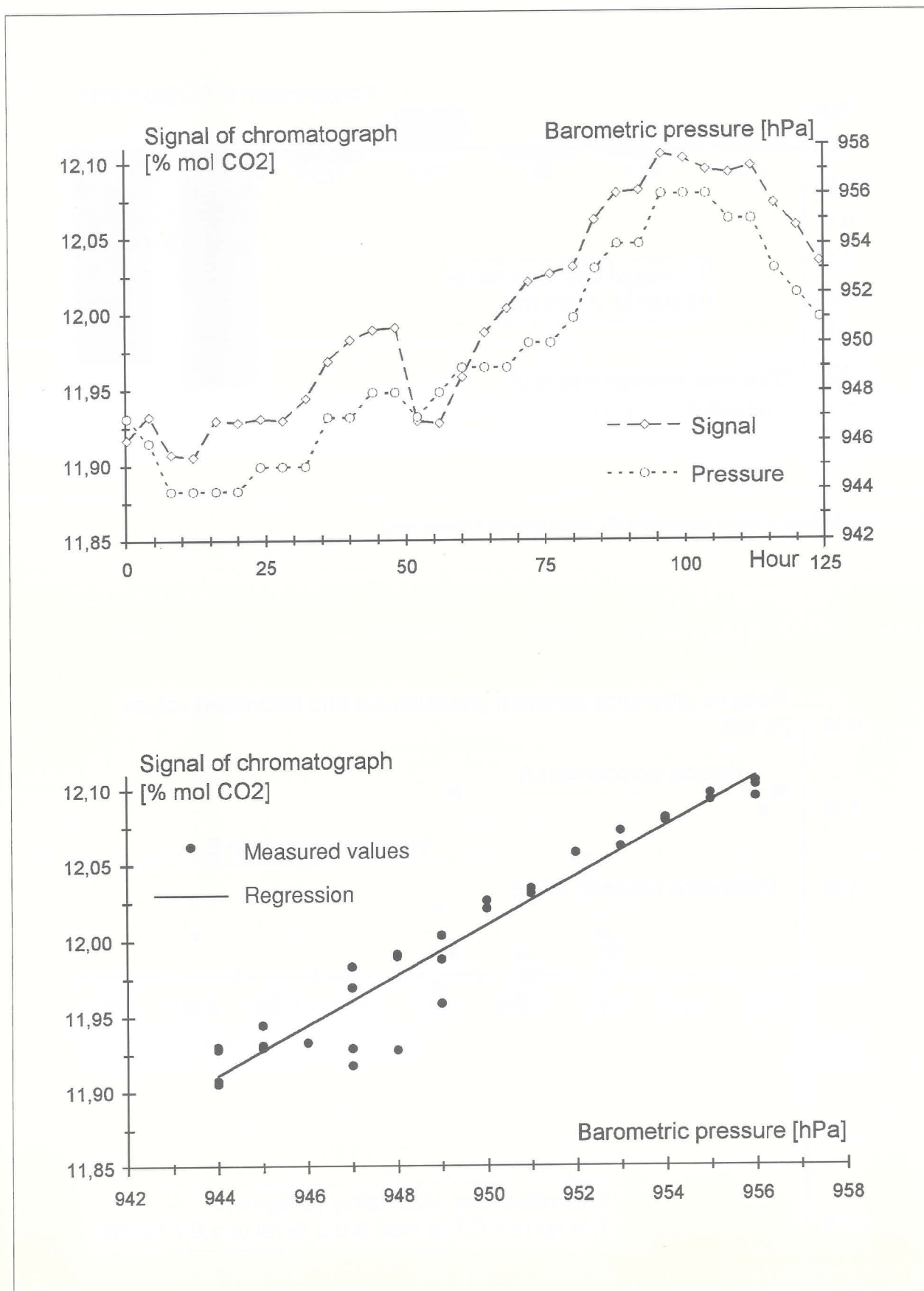


Fig. 5 Correlation between chromatograph signal and barometric pressure

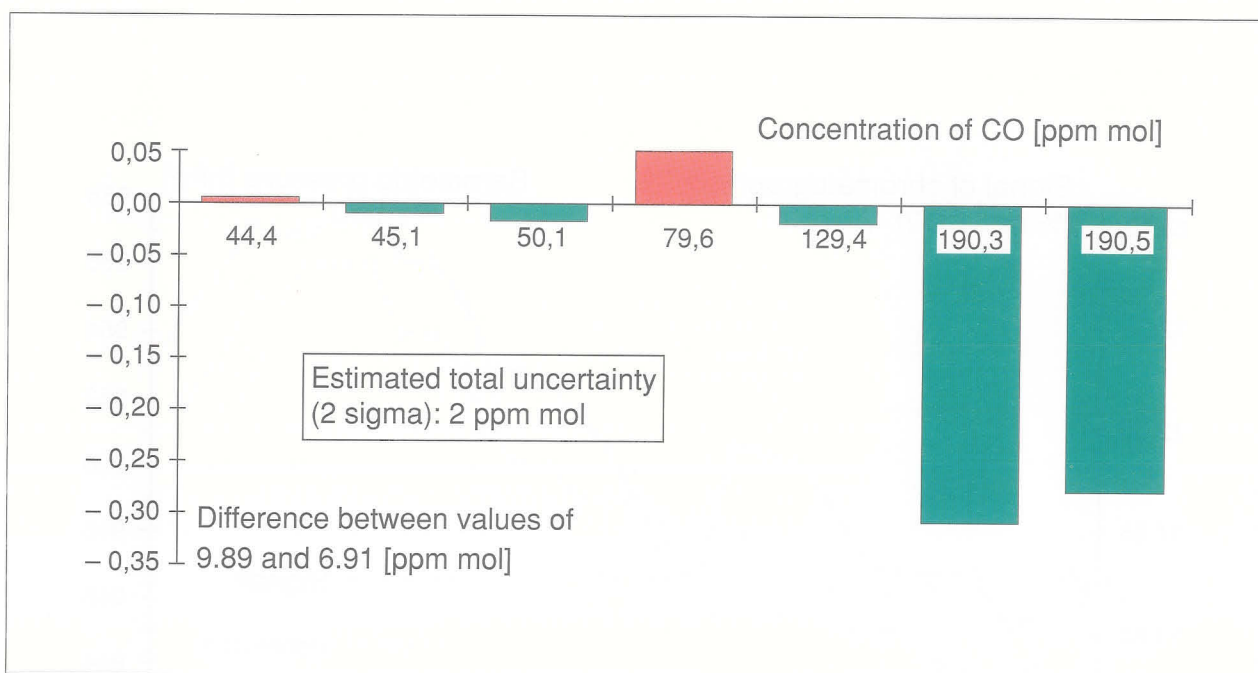


Fig. 6 Reproducibility of vertical comparisons (21 months between 2 comparisons)

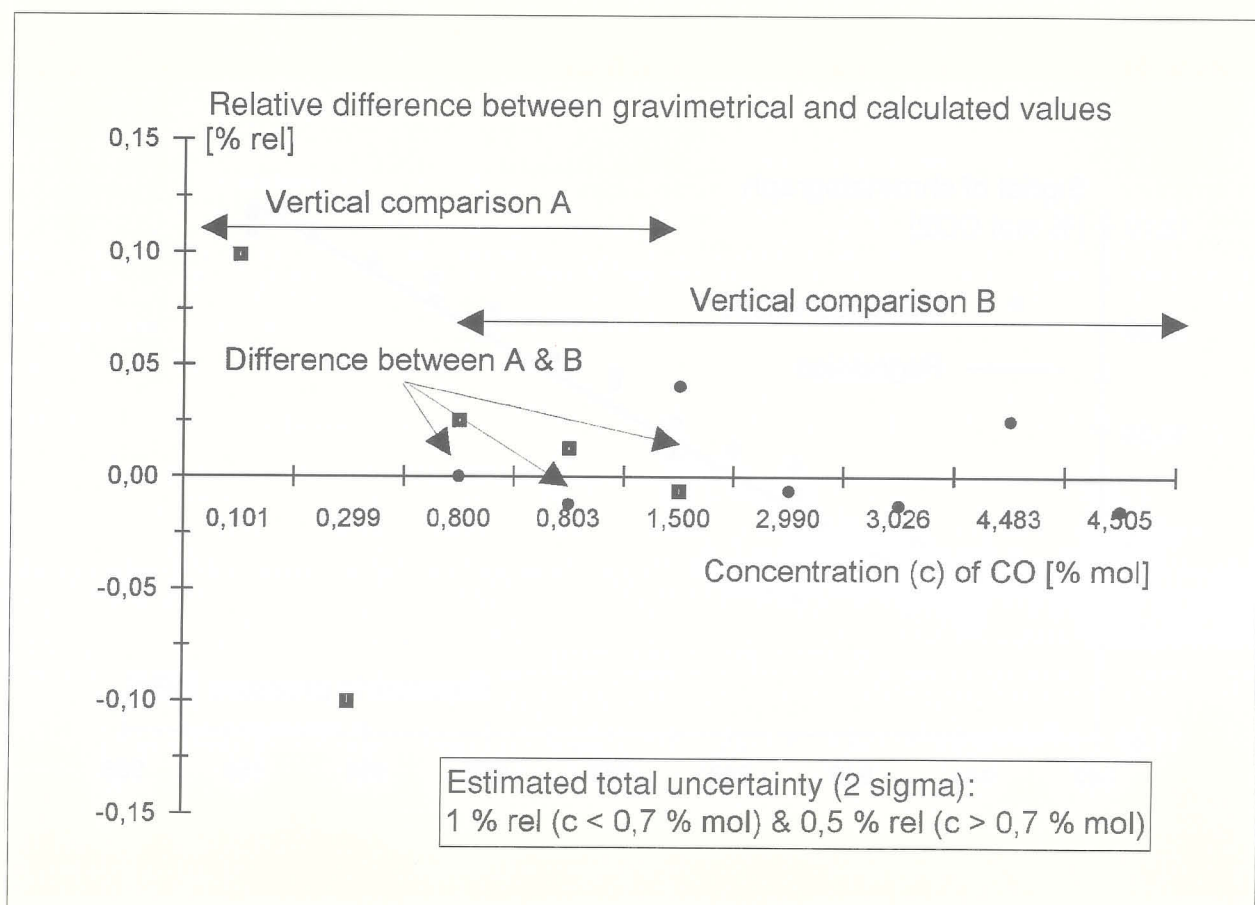


Fig. 7 Agreement of results between two vertical comparisons



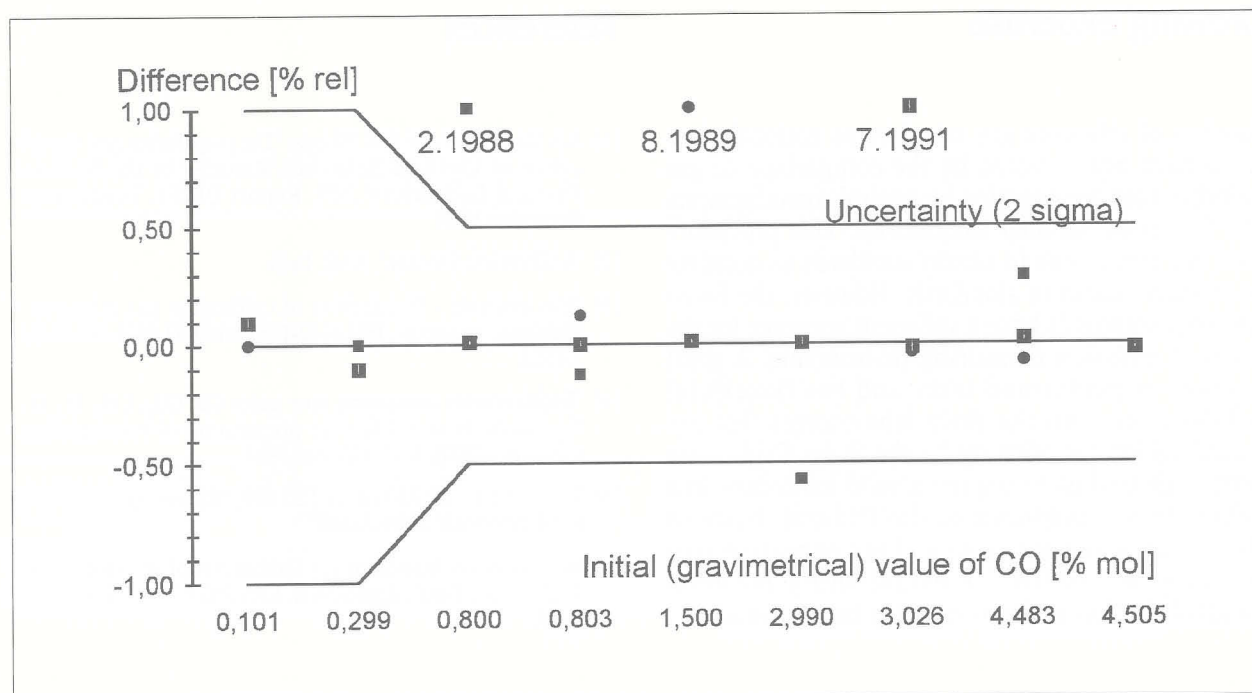


Fig. 8 Agreement of values of OFMET standards within three vertical comparisons (1988, 1989, 1991)

## A short outlook... immission measuring systems

As we showed, a whole "family" of national standards has been set up for gas concentrations in mixtures and used for some emission measuring instruments. At present, we are studying the realization of national standards to be applied to measuring instruments for pollutant immissions. It is obvious that the know-how already acquired is useful, but additional problems are arising, some of which are quite new and different from those already mentioned:

- The impurities in the ballast gas ( $N_2$  or air) can no longer be neglected. The degree of purity of, say, 99.9999 % is something out of the ordinary, but represents an overall concentration of residual gases of  $10^{-6}$  mol/mol and is therefore 10 times higher than the target concentrations considered in the reference gas mixtures (100 ppb =  $10^{-7}$  mol/mol)! The question arises as to whether the fraction of the target component might already be included in the impurity residues of the ballast gas (systematic error of gas mixture production). There are also impurities that react with the components used, rendering the mixture unstable (see e.g.  $SO_2$  and water vapor).
- Even more tricky: possible cross-effects in particular types of sensors (we found this effect with some cylinders of such a high concentration as 3 % mol of CO used with a specific type of instrument for the measurement of vehicle exhaust emissions. At the Swiss Federal Testing Laboratory (EMPA), a study revealed the presence of an impurity component that could be neither quantified nor even identified [5].
- Insufficient stability may be a general problem for gas mixtures containing concentrations of less than 1 ppm. For this reason, some laboratories prefer to use somewhat higher concentrations than the stock (in cylinder) and to employ dilution techniques. The standard then comprises the cylinder with the gas mixture as well as a dilution system. The metrological verification and the traceability of the dilution system are just as important as the certification of the cylinder.
- The ozone [an unstable gas in itself] requires yet another quite different technique: here the standard is a measuring device and not a reference material (gas in cylinder) [6]. The OFMET is just starting work in this field and we hope to take advantage of the experiences gained by other national laboratories; we wish to express here our thanks to them for their valuable support.

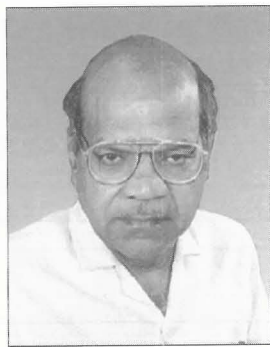
## Growing expertise

Families of reference gas mixtures as national standards have been created by the comparison of gas cylinders that are supplied by several manufacturers and European national laboratories. This procedure does not permit one to obtain standards as accurate as primary reference standards. However, the Swiss reference standards have a sufficient accuracy for the needs of emission measuring instruments. A great number of performed tests and the beneficial collaboration with the three laboratories that are accredited for gas mixtures by the Swiss Calibration Service allowed us to acquire a solid know-how in a field that was unknown to the Federal Office of Metrology a few years ago. This expertise will certainly be useful for establishing national standards for immission measuring instruments.

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- [4] "Requirements concerning pure gases CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub> and Ar intended for the preparation of reference gas mixtures", OIML R 73, October 1984.
- [5] Test report 120 220 of 11.12.1989, "Eichgasgemisch 3 % Kohlenmonoxid in Stickstoff".
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## Pursuit of quality in India

### FABRICATION OF KNIFE-EDGES FOR A HIGH PRECISION BALANCE

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Section, National Physical Laboratory, New Delhi, India

**F**OLLOWING is a technical perspective on the fabrication of high quality knife-edges in India. Techniques, design, and methods are presented.

The performance of a swinging balance largely depends on the quality of the incorporated knife-edges. Hard chrome-plated knife-edges are superior to other types in many respects: the coefficient of friction of electroplated chromium with another metal is very low and it is self lubricating [1]; it is very hard and highly abrasion and corrosion resistant. Again, if the material of the beam of a balance is the same as that of the knife-edge substrate, the coefficient of thermal expansion would be the same for both.

There exists a report by NPL, Teddington [2] on making hard chrome plated knife-edges. It is difficult to obtain bright and thick deposits of chromium if chromium and sulphate contents of the solution are not maintained properly. Temperature of the solution and applied current density are also to be maintained properly [3,4]. The cathode efficiency of chromium is very low and the covering power is poor. A total of 15 hours was required to obtain the desired thickness (0.18 mm) of chromium at the top of the substrates. The top of the substrate knife-edge was kept flat so that the thickness of deposited chromium would be high at the top and as a result, the thrust of the balance beam would fall mainly on plated chromium.

The problem of treeing by the deposited chromium was very acute: the deposition of chromium was more concentrated at the two ends of the knife-edges than other areas. To reduce treeing, thin metallic conductors were used as shields. By noting the mass gain of the knife edges after electroplating, the average thickness of the plated chromium was determined by using the following formula:  $\text{thickness} = \text{mass gain/density} \times \text{area}$  [5].

### Design

In figures 1 and 2, the designs of the central knife-edge and the end knife-edge respectively are given. The full line represents the shape of the substrate before chromium plating. The dotted line represents the final shape of the knife-edges after polishing.

### Preparation and cleaning of the substrates

Substrate knife-edges were first fabricated from gun metal. Then they were cleaned electrolytically by using the following solution:

- Sodium carbonate: 20 g/l
- Trisodium phosphate: 9 g/l
- Sodium hydroxide: 7 g/l

The bath temperature was maintained at about 80°C. A steel plate was used as anode and a cathodic current density (C.D.) of 400 A/m<sup>2</sup> was applied.

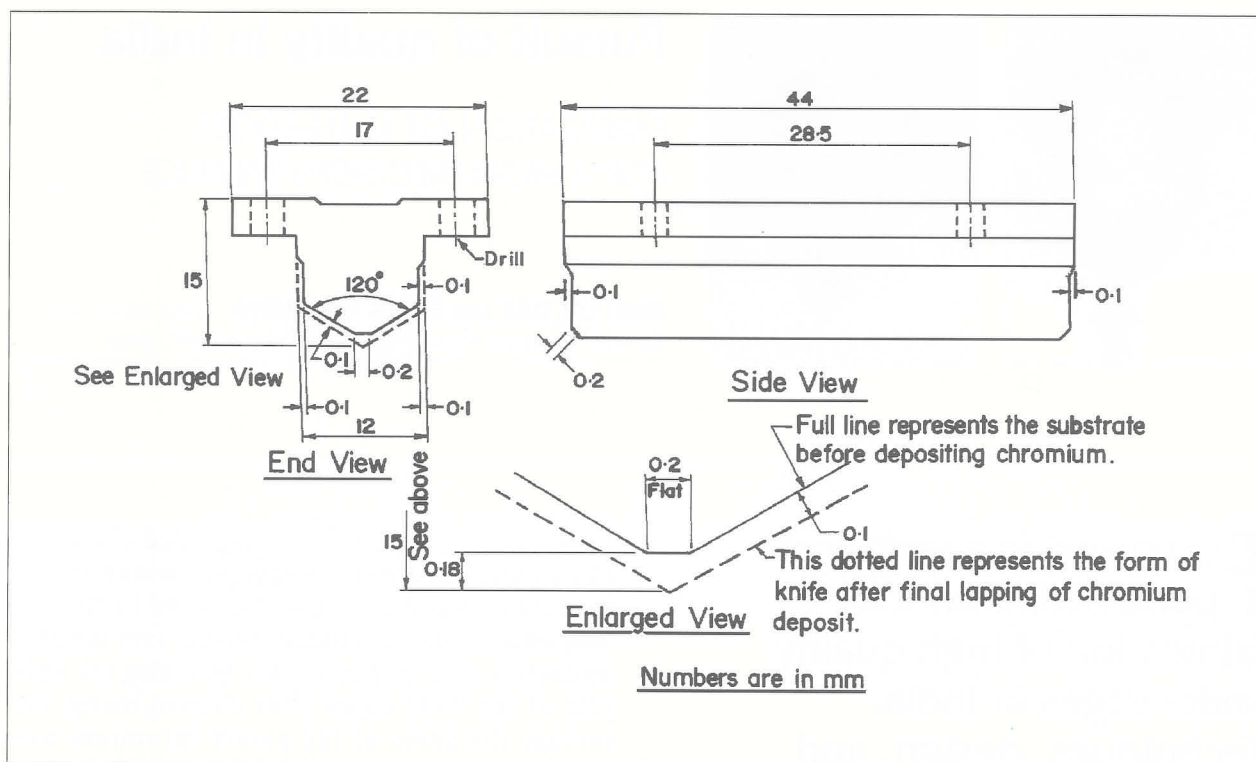


Fig. 1 Central knife-edge (not drawn to scale)

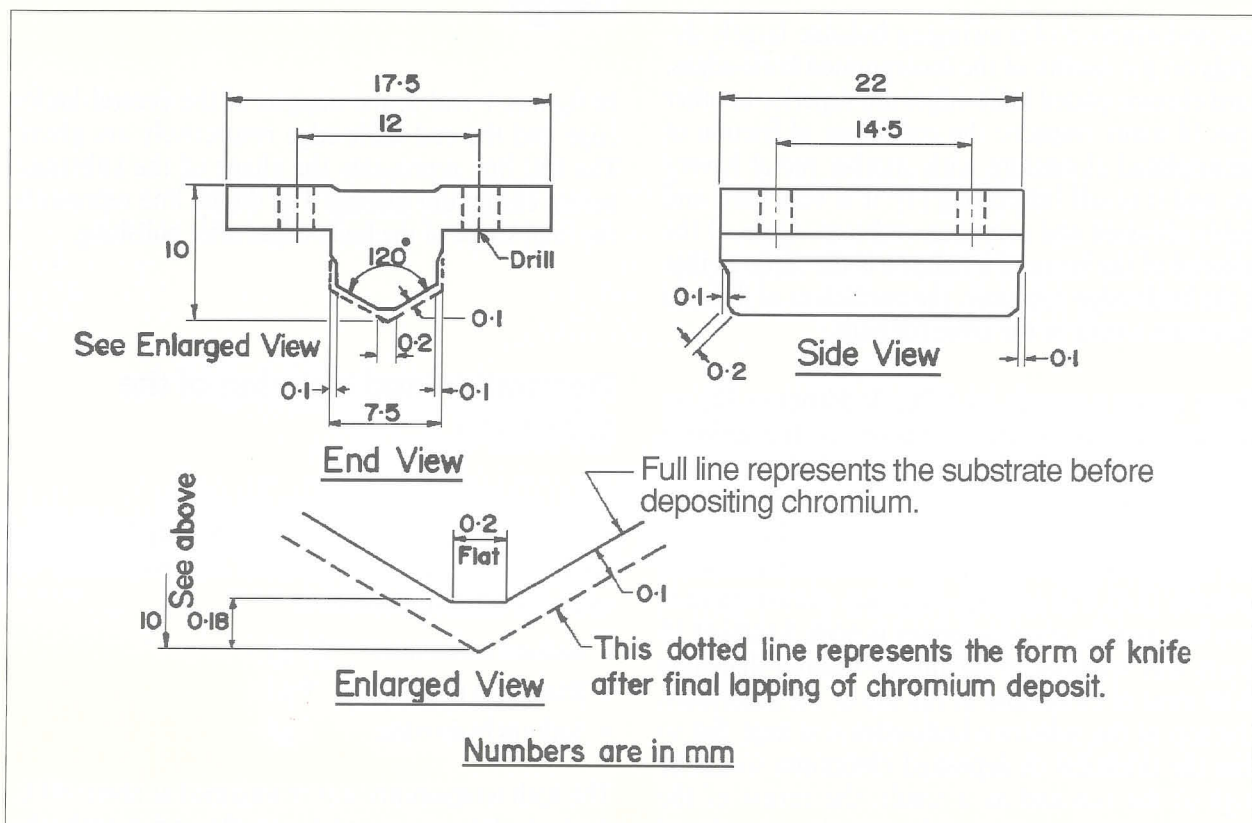


Fig. 2 End knife-edge (not drawn to scale)



## Shielding

Two thin brass wires were fitted at the two ends of the knife-edge. The wires were made cathodic. A portion of the chromium metal was deposited on brass wires and the deposition of chromium was less at two ends; as a result, treeing was reduced.

## Hard chrome plating

For making the chrome plating solution, the following composition was used:

- Chromic acid (anhydrous): 250 g/l
- Sulphuric acid: 2.5 g/l

An antimonial lead bar was used as an anode. After electrocleaning, the substrates were introduced into the plating bath. First, a strike was given for 30 seconds in the plating bath itself by making the C.D. 4 000 A/m<sup>2</sup>.

The C.D. was then lowered to 3 000 A/m<sup>2</sup>. The temperature was maintained at 50 °C. Plating was continued for five hours. The knife-edge was then removed from the plating bath and polished to remove any excess chromium on the edges.

At the second stage, chromium was plated onto chromium by adhering to the following sequences:

- (i) The knife-edge was cleaned cathodically for two minutes and anodically for one minute in the electrocleaning solution mentioned earlier at a C.D. of 1 000 A/m<sup>2</sup>.
- (ii) The knife-edge was then rinsed in distilled water and etched anodically in the plating solution for 30 seconds at 50 °C and at a C.D. of 3 000 A/m<sup>2</sup>.
- (iii) Electrical connections were removed and knife-edges were allowed to remain idle in the tank for 10 minutes.
- (iv) The connections were restored and a small current was allowed to pass (at which hydrogen evolution at the cathode just began). The knife-edge was kept at this current for 10 minutes.
- (v) Finally, the current was increased slowly until it reached 3 000 A/m<sup>2</sup> and the knife-edge was plated for five hours.

After the above operation, the knife-edge was polished slightly and excess chromium was removed.

At the third stage, the knife-edge was plated for another five hours following the same steps as in the second stage.

## Final polishing and edge-width

To prevent the removal of material at the edges, the knife-edges were polished with the help of blocks and plaster. In order to be used as blocks, a large number of triangular prisms of gun metal were plated with chromium in the same way as the knife-edges. The block was placed in contact with the knife-edge in such a way that their two faces lay in the same plane. The combination was then grinded, lapped, and polished with emery powder and diamond paste.

The measurement of straightness and edge-width of the knife-edges were conducted on the interference microscope and the metallurgical microscope. The edge-width was found to be a few micrometers, which is the requirement for a knife-edge to be used in a high precision balance [2].

## Concluding remarks

By plating very thick (hard) chromium on gun metal substrates, it is possible to fabricate knife-edges that demonstrate high performance. At present, we are using this type of knife-edge in the 1 kg remote-controlled balance that has been fabricated in our laboratory. The balance beam is made of gun metal and gives an accuracy of a few parts per 100 million.

## References

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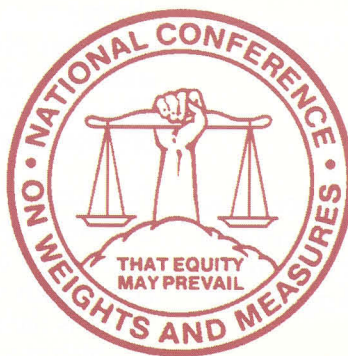
## Excellence through standards

### THE US NATIONAL CONFERENCE ON WEIGHTS AND MEASURES HOLDS ITS 78th ANNUAL MEETING

KANSAS CITY, MISSOURI USA  
18-22 JULY 1993

**S**ERIOUS problems with heavy rain and flooding in the midwest region of the United States did not prevent the American National Conference on Weights and Measures (NCWM) from holding its 78th Annual Meeting in Kansas City, Missouri, USA, 18-22 July 1993.

"Excellence through Standards" was the theme of this year's meeting of the Conference which boasted its highest participation since 1979. Allan Nelson, Director of the Weights and Measures and Product Safety Division of the Connecticut Department of Consumer Protection, presided over the Conference which counted a



participation of more than 400 delegates.

The purpose of the NCWM is to provide an opportunity for representatives from American industry, business, government, consumer organizations, and

weights and measures officials to establish uniform standards through a consensus building process. These standards become requirements in most of the United States.

Since its establishment in 1905, the secretariat and sponsor of the NCWM is the US National Institute of Standards and Technology (NIST). Samuel E. Chappell, Chief of the Standards Management Program at NIST and OIML's International Committee member for the United States was among the Conference participants.



Allan Nelson, NCWM Chairman, addresses the Conference.

#### OIML MAKES AN IMPACT

The *Organisation Internationale de Métrologie Légale* (OIML) was represented at the NCWM meeting by Bernard Athané, Director of the Organization's secretariat *Bureau International de Métrologie Légale* (BIML) located in Paris, France and Kristine French, responsible for Communications at BIML. Mr Athané and Ms French delivered a speech outlining OIML's pursuit of excellence through its International Recommendations and the new directions for its Certificate System. The OIML speakers also



addressed the developments of the Organization's external communications (\*).

In response to the presentation, a number of US manufacturers and weights and measures officials expressed a high degree of interest in OIML and expect to increase their participation in the Organization's activities.

## CONTRIBUTING TO THE NCWM MEETING

Other international contributions to the meeting included a speech by Graham Harvey, Deputy Director of the National Standards Commission in Australia, entitled *"The status of privatization in Australia"* and an address by Robert Bruce, Chief of Weights and Measures for Canada, covering *"Mutual recognition of Canada and the United States type evaluation and future collaborations"*. The subjects of privatization and national type approval programs were also addressed by American speakers (see below).

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(\*) The OIML presentation is reproduced on page 28.



Delegates to the 78th Annual Meeting of the US National Conference on Weights and Measures.

## National type approval programs

**John Elengo, Chairman, National Type Evaluation Committee (NTETC)**

*"The history, milestones, and future of the NTETC and its sectors"*

**James Truex, Weights and Measures Inspection Manager, Ohio Department of Agriculture**

*"How a regulatory jurisdiction implements NTEP and why"*

## Privatization

**Thomas Geiler, Chairman, NCWM Privatization Working Group**

*"Privatization: what it means to those who oppose it and to those who welcome it"*



# L'excellence par les normes

## LA CONFERENCE NATIONALE DES POIDS ET MESURES AUX ETATS-UNIS D'AMERIQUE TIENT SA 78<sup>e</sup> RÉUNION ANNUELLE

KANSAS CITY, MISSOURI USA  
18-22 JUILLET 1993

**L**es sérieux problèmes de la région du "midwest" des Etats-Unis, suite aux pluies diluviennes et aux inondations catastrophiques, n'ont pas empêché la Conférence Nationale des Poids et Mesures (NCWM) de tenir sa 78<sup>e</sup> réunion à Kansas City, Missouri, USA, du 18 au 22 juillet 1993.

"L'excellence par les normes" était le thème de la Conférence qui a battu cette année tous les records de participation jamais enregistrés depuis 1979. Allan Nelson, Directeur de la Division des Poids et Mesures et de la Sécurité des Produits au Département de la Protection du Consommateur du Connecticut, a présidé la Conférence à laquelle plus de 400 délégués ont participé.

L'objet de la NCWM est d'offrir une opportunité aux représentants de l'industrie, des affaires, du gouvernement, des associations de consommateurs, et des agents des poids et mesures américains, d'établir des normes harmonisées par un processus d'obtention de consensus. Ces normes deviennent obligatoires dans la plupart des Etats américains.

Depuis sa création en 1905, le secrétariat et sponsor de la NCWM est le "National Institute of Standards and Technology" (NIST).



Samuel E. Chappell, Chef du "Standards Management Program" au NIST et membre pour

les Etats-Unis du Comité International de Métrologie Légale, était au nombre des participants à la Conférence.

### IMPACT DE L'OIML

L'Organisation Internationale de Métrologie Légale (OIML) était représentée à la réunion de la NCWM par Bernard Athané, Directeur du *Bureau International de Métrologie Légale (BIML)*, le se-



K. Newell, W. Warshaw, S. Warshaw (NIST) et  
T. Geiler, Président de la NCWM pour 1993-1994.



crétariat de l'Organisation, situé à Paris, France et par Kristine French, qui est responsable de la Communication au BIML. Mr Athané et Mlle French ont, dans leur exposé, décrit la recherche par l'OIML de l'excellence dans ses Recommandations Internationales et les nouvelles directions de son Système de certificats. Les conférenciers OIML ont également abordé le développement des communications externes de l'Organisation (\*).

En réaction à cette présentation, plusieurs constructeurs et agents des poids et mesures américains ont manifesté un grand intérêt pour l'OIML et envisagent d'accroître leur participation aux activités de l'Organisation.

## CONTRIBUTIONS A LA NCWM

Les autres contributions internationales à la réunion ont inclu un exposé de Graham Harvey, Deputy Director, National Standards Commission, Australie, intitulé "The status of privatization in Australia" et un discours de Robert Bruce, Chief of Weights and Measures, Canada, sur "Mutual recognition of Canada and the United States type evaluation and future collaborations". Les sujets de privatisation et de programmes nationaux d'approbation de modèle ont également été traités par des conférenciers américains (voir ci-contre).

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(\*) L'exposé de l'OIML est donné en page 28.



Carroll Brickenkamp, Executive Secretary, NCWM.

## Programmes nationaux d'approbation de modèle

**John Elengo, Chairman, National Type Evaluation Committee (NTETC)**

*"The history, milestones, and future of the NTETC and its sectors"*

**James Truex, Weights and Measures Inspection Manager, Ohio Department of Agriculture**

*"How a regulatory jurisdiction implements NTEP and why"*

## Privatisation

**Thomas Geiler, Chairman, NCWM Privatization Working Group**

*"Privatization: what it means to those who oppose it and to those who welcome it"*



# OIML meets the NCWM

## EXCELLENCE IN OIML RECOMMENDATIONS... A STEP FORWARD

PRESENTATION BY BERNARD ATHANÉ AND KRISTINE FRENCH

Bureau International de Métrologie Légale



### VOYAGE TOWARDS INTERNATIONAL HARMONIZATION

**W**E'RE here today because Kansas City happened to be on our road towards international harmonization in the field of metrology. This Conference is all about excellence through standards. Before continuing on our journey, we'd like to share with you our own pursuit of excellence through a special category of international standards, the OIML Recommendations.

US NATIONAL CONFERENCE  
on WEIGHTS and MEASURES  
78th Annual Meeting  
Kansas City, Missouri  
18-22 July 1993

But first, did you know that OIML and the NCWM have many things in common? The NCWM defines itself as a standard writing organization for weights and measures regulatory agencies of the States, counties, and cities of the United States.

We too develop model regulations for use by the legal metrology

services of the 51 nations that make up OIML, plus the 38 other nations registered as Corresponding Members.

We too bring together government officials, manufacturers and users of measuring instruments, and representatives of other interested parties.

The NCWM and OIML work towards the same ends: NCWM strives to produce weights and measures model standards for voluntary implementation in the United States; OIML's activities aim at formulating legal metrology model Recommendations that are also voluntarily accepted by our members and transformed into national laws and regulations. Therefore, OIML and the NCWM are both concerned with weights and measures. But there is much more to legal metrology than weights and measures!

Measurement credibility in the field of trade is of essential importance and is the main priority of the NCWM; of course, work in this field is also an important responsibility for OIML.

But there are other fields, such as the environment, health, and safety, in which credibility in measurement is essential as well.

American agencies such as the Food and Drug Administration and the Environmental Protection Agency are responsible for



*Bernard Athané and Kristine French address the NCWM.*



developing the relevant federal regulations. Insofar as measuring instruments are concerned, there is a role to be played by OIML for internationally harmonizing the applicable metrological requirements.

Complementary to the regulatory activity that applies to metrological performances of measuring instruments, there may be a need for a more general standardization activity.

International institutions such as ISO or IEC and American bodies, such as ANSI or ASTM, are responsible for this activity. There is a need for close coordination between standardization and legal metrology and we will address this later.

The question is: How can OIML reach its ambitious destination of international harmonization in legal metrology?

## EXCELLENCE THROUGH OIML RECOMMENDATIONS

An OIML Recommendation is a model regulation that specifies the necessary metrological performances for particular measuring instruments. It also provides the methods for testing conformity, and the format for reporting the test results.

OIML Recommendations are the necessary tools for building the pillars of an international environment in which all interests can be served. Whose interests are we referring to? Those of the legal metrology officials since they are charged with the

development and the implementation of regulations; those of the users of instruments because of their reliance on the measurement accuracy.

We are also referring to the interests of the manufacturers of measuring instruments. Certain regions, such as North America or the European Economic Area, are introducing new directives that would affect the free circulation of products if they were not based on common international recommendations. What American manufacturer would not see the interest in contributing to the establishment of metrological requirements beyond the US borders?

The importance of this vantage point was expressed in March of this year during the annual conference of the American National Standards Institute in Washington D.C. John Kinn, consultant and retired Vice President of the Electronic Industries Association, expressed that:

*The recognition of the need to become globally competitive by U.S. manufacturers is a positive step towards the ultimate development of single worldwide standards. However, in this process of internationalization, steps must be taken to assure that regional viewpoints (North American for example), continue to be developed and provided while at the same time minimizing the cost of development of international standards to industry.*

*(Quoted from the ANSI Reporter, May 1993)*

So an OIML Recommendation can be one of the tools for increasing global competitiveness. But how?

Allow us to cite the ANSI Reporter as our source for the following:

*To compete in today's global marketplace, American businesses must: create synergies with former competitors; effectively participate in the definition of standards which will determine rules for international competition; and anticipate potential new standards and determine their impact on technology and markets.*

Ronald Saporita  
Grace Specialty Chemical Co.

American experts can indeed determine the rules by participating in OIML work through active contribution to the technical committees and subcommittees. Their expertise and regional views can help mold the formulation of the Recommendations. And since these Recommendations are usually implemented through the national regulations of OIML Member States, US manufacturers would have a significant role in preventing potential commercial barriers.

US experts can contribute to OIML's pursuit of excellence in Recommendations with their experience and know-how; as a result, they would permit US manufacturers to have unlimited access to international markets, through these Recommendations.

The OIML Certificate System constitutes an expressway to international markets. We know that general information on this System has been given to the NCWM through our Vice-President, Dr Samuel E. Chappell from NIST; so we can be brief on this topic.

At present, the System applies to a limited number of instrument types: mainly the nonautomatic



weighing instruments. Soon, it will apply to load cells, automatic weighing instruments, and later, to gasoline pumps or other liquid meters.

The System became operational last year and at present, six certificates have been issued. At least one country has accepted an instrument on the sole basis of the OIML certificate and some developing countries have already decided to favor the importation of certified instruments.

Therefore, we believe that it is worthwhile for US manufacturers to apply for these certificates: either through NIST or when applying for a European pattern approval. The additional cost of obtaining the OIML certificate is low compared to the added value that it will have when exporting the instrument.

The finishing touch of excellence in OIML Recommendations will result from our efforts to base these Recommendations not only on expertise, but also on inter-comparisons that clearly demonstrate the value of the requirements and test methods.

This exercise may be difficult and costly. However, some tentatives in fields such as the humidity of cereals, load cells and non-automatic weighing instruments have already proven their value.

PERHAPS YOU HAVEN'T  
HEARD YET...  
SO LET US TELL YOU ABOUT  
OIML'S NEED TO  
COMMUNICATE

OIML is re-defining its long-term policies and objectives and the importance of developing an

efficient communication network between the various partners in legal metrology has not been overlooked.

The field of legal metrology is increasingly interconnected with other domains such as accreditation, certification, and quality assurance. In fact, in many countries, the classical legal metrology service is no longer the only body responsible for performing all the tasks associated with the control of measuring instruments. Other accredited bodies may be charged with such tasks.

These evolutions, as well as the appearance of new actors on the scene, influence OIML's global strategy. This is why we feel it is necessary to expand the scope of our communications to respond to the growing diversity of interests in metrology.

You have received a brochure that describes one of our organization's channels for transmitting information: the OIML Bulletin.

We encourage you to contact us at BIML for a free copy of our next double issue of the OIML Bulletin which will feature the new orientations of our communication strategy.

We are convinced of the value of OIML's international leadership in legal metrology. That is why we intend to reach out to those of you working in areas ranging from legal metrology to standardization; government to industry; and verification to accreditation and certification. OIML can give you access to the road that will take you in the right direction. And we plan on doing this, in part, by fine-tuning our instruments of communication.

EN ROUTE TOWARDS  
INTERNATIONAL  
HARMONIZATION

CO-EXISTENCE:  
THERE'S ROOM  
FOR EVERYONE  
ON THE ROADS!

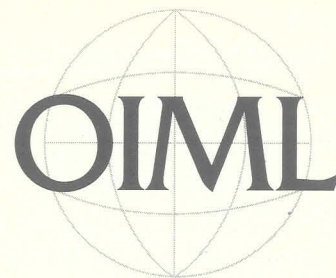
There is not just one road to international harmonization. And since it is a highly sought-after destination, there are, of course, many different travelers heading in the same direction. This leads us to our final point. We encourage the peaceful co-existence of the international and regional bodies concerned with legal metrology and standardization.

This is necessary not only for assuring compatibility between the legal metrology and standardization provisions, but also to save time and resources in our pursuit of international harmonization. There are international agreements that permit an appropriate distribution of responsibilities, mutual references, and joint activities. Therefore, you can participate in OIML work AND standardization activities and remain confident that the benefits will be shared in both domains.

Come with us on our journey to international harmonization of measuring instruments. Gain speed by participating in OIML's technical activities. Of course, you'll need a road map which you'll find in the OIML Bulletin and an OIML certificate will serve as your international driving permit! We are confident that you won't even consider turning back! Thank you and we'll see you on the road ahead.



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## P U B L I C A T I O N S

Below is a list of OIML publications classified by subject (\*) and indicated as follows: International Recommendations (R), International Documents (D), vocabularies (V), and other publications (P). Publications are available in French and English in the form of separate leaflets, unless otherwise indicated.

Publications may be ordered(\*\*) by letter or fax from:

BUREAU INTERNATIONAL DE MÉTROLOGIE LÉGALE  
11, RUE TURGOT, 75009 PARIS, FRANCE  
TEL: 33 1 48 78 12 82 OR 33 1 42 85 27 11  
FAX: 33 1 42 82 17 27

*On trouvera ci-dessous une liste des publications OIML classées par sujets(\*) et indiquées comme suit: Recommandations Internationales (R), Documents Internationaux (D), vocabulaires (V) et autres publications (P). Ces publications sont disponibles en français et en anglais sous forme de fascicules séparés sauf indication contraire.*

### GENERAL

#### GÉNÉRALITÉS

**R 34** 1979 - 1974 60 FRF

Accuracy classes of measuring instruments  
*Classes de précision des instruments de mesurage*

**R 42** 1981 - 1977 50 FRF

Metal stamps for verification officers  
*Poinçons de métal pour Agents de vérification*

**D 1** 1975 50 FRF

Law on metrology  
*Loi de métrologie*

**D 2** (in revision - en cours de révision)

Legal units of measurement  
*Unités de mesure légales*

**D 3** 1979 60 FRF

Legal qualification of measuring instruments  
*Qualification légale des instruments de mesurage*

**D 5** 1982 60 FRF

Principles for the establishment of hierarchy schemes for measuring instruments  
*Principes pour l'établissement des schémas de hiérarchie des instruments de mesure*

**D 9** 1984 60 FRF

Principles of metrological supervision  
*Principes de la surveillance métrologique*

**D 12** 1986 50 FRF

Fields of use of measuring instruments subject to verification  
*Domaines d'utilisation des instruments de mesure assujettis à la vérification*

**D 13** 1986 50 FRF

Guidelines for bi- or multilateral arrangements on the recognition of: test results - pattern approvals - verifications  
*Conseils pour les arrangements bi- ou multilatéraux de reconnaissance des: résultats d'essais - approbations de modèles - vérifications*

**D 14** 1989 60 FRF

Training of legal metrology personnel - Qualification - Training programmes  
*Formation du personnel en métrologie légale - Qualification - Programmes d'étude*

**D 15** 1986 80 FRF

Principles of selection of characteristics for the examination of measuring instruments  
*Principes du choix des caractéristiques pour l'examen des instruments de mesure usuels*

**D 16** 1986 80 FRF

Principles of assurance of metrological control  
*Principes d'assurance du contrôle métrologique*

**D 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*

(\*) A list of publications classified by number may be obtained from BIML.  
*Une liste des publications par numéro est disponible auprès du BIML.*

(\*\*) Prices are given in French francs and do not include postage.  
*Les prix sont donnés en francs français et ne comprennent pas les frais d'expédition.*



- D 19** 1988 80 FRF  
Pattern evaluation and pattern approval  
*Essai de modèle et approbation de modèle*
- D 20** 1988 80 FRF  
Initial and subsequent verification of measuring instruments and processes  
*Vérifications primitive et ultérieure des instruments et processus de mesure*
- V 1** 1978 100 FRF  
Vocabulary of legal metrology (bilingual French-English)  
*Vocabulaire de métrologie légale (bilingue français-anglais)*

**V 2** (in revision - en cours de révision)  
International vocabulary of basic and general terms in metrology (bilingual French-English)  
*Vocabulaire international des termes fondamentaux et généraux de métrologie (bilingue français-anglais)*

**P 1** 1991 60 FRF  
OIML Certificate System for Measuring Instruments  
*Système de Certificats OIML pour les Instruments de Mesure*

**P 2** 1987 100 FRF  
Metrology training - Synthesis and bibliography (bilingual French-English)  
*Formation en métrologie - Synthèse et bibliographie (bilingue français-anglais)*

**P 3** 1990 200 FRF  
Metrology in Member States and Corresponding Member Countries  
*Métrologie dans les Etats Membres et Pays Membres Correspondants de l'OIML*

**P 9** 1992 100 FRF  
Guidelines for the establishment of simplified metrology regulations

## MEASUREMENT STANDARDS

### ÉTALONS

**D 6** 1983 60 FRF  
Documentation for measurement standards and calibration devices  
*Documentation pour les étalons et les dispositifs d'étalonnage*

**D 8** 1984 60 FRF  
Principles concerning choice, official recognition, use and conservation of measurement standards  
*Principes concernant le choix, la reconnaissance officielle, l'utilisation et la conservation des étalons*

**D 10** 1984 50 FRF  
Guidelines for the determination of recalibration intervals of measuring equipment used in testing laboratories  
*Conseils pour la détermination des intervalles de réétalonnage des équipements de mesure utilisés dans les laboratoires d'essais*

**D 23** 1993 80 FRF  
Principles of metrological control of equipment used for verification  
*Principes du contrôle métrologique des équipements utilisés pour la vérification*

**P 4** 1986 - 1981 100 FRF  
Verification equipment for National Metrology Services  
*Équipement d'un Service national de métrologie*

**P 6** 1987 100 FRF  
Suppliers of verification equipment (bilingual French-English)  
*Fournisseurs d'équipement de vérification (bilingue français-anglais)*

**P 7** 1989 100 FRF  
Planning of metrology and testing laboratories  
*Planification de laboratoires de métrologie et d'essais*

**P 15** 1989 100 FRF  
Guide to calibration

## MASS AND DENSITY

### MASSES ET MASSES VOLUMIQUES

**R 1** (in revision - en révision)  
Cylindrical weights from 1 gram to 10 kilograms of medium accuracy class  
*Poids cylindriques de 1 gramme à 10 kilogrammes de la classe de précision moyenne*

**R 2** (in revision - en révision)  
Rectangular bar weights from 5 kilograms to 50 kilograms of medium accuracy class  
*Poids parallélépipédiques de 5 à 50 kilogrammes de la classe de précision moyenne*

**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 20** (in revision - en cours de révision)  
Weights of accuracy classes  $E_1$ ,  $E_2$ ,  $F_1$ ,  $F_2$ ,  $M_1$  from 50 kg to 1 mg  
*Poids des classes de précision  $E_1$ ,  $E_2$ ,  $F_1$ ,  $F_2$ ,  $M_1$  de 50 kg à 1 mg*

**R 22** 1975 150 FRF  
International alcoholometric tables (trilingual French-English-Spanish version)  
*Tables alcoométriques internationales (version trilingue français-anglais-espagnol)*

**R 25** (in revision - en cours de révision)  
Standard weights for verification officers  
*Poids étalons pour Agents de vérification*

**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** (in revision - en cours de révision)  
Continuous totalising automatic weighing machines  
*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*
- R 61** 1985 80 FRF  
Automatic gravimetric filling machines  
*Doseuses pondérales à fonctionnement automatique*
- R 74** (being printed - en cours de publication)  
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-basculés 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)*
- P 5** 1992 100 FRF  
Mobile equipment for the verification of road weigh-bridges (bilingual French-English)  
*Équipement mobile pour la vérification des ponts-basculés routiers (bilingue français-anglais)*
- P 8** 1987 100 FRF  
Density measurement  
*Mesure de la masse volumique*

## LENGTH AND SPEED LONGUEURS ET VITESSES

- R 21** 1975 - 1973 60 FRF  
Taximeters  
*Taximètres*

- R 24** 1975 - 1973 50 FRF  
Standard one metre bar for verification officers  
*Mètre étalon rigide pour Agents de vérification*
- R 30** 1981 60 FRF  
End standards of length (gauge blocks)  
*Mesures de longueur à bouts plans (cales étalons)*
- R 35** 1985 80 FRF  
Material measures of length for general use  
*Mesures matérialisées de longueur pour usages généraux*
- R 55** 1981 50 FRF  
Speedometers, mechanical odometers and chronotachographs for motor vehicles. Metrological regulations  
*Compteurs de vitesse, compteurs mécaniques de distance et chronotachygraphes des véhicules automobiles. Réglementation métrologique*
- R 66** 1985 60 FRF  
Length measuring instruments  
*Instruments mesureurs de longueurs*
- R 98** 1991 60 FRF  
High-precision line measures of length  
*Mesures matérialisées de longueur à traits de haute précision*

- 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*

## 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 futaillies*

**R 49** 1979 - 1977 60 FRF

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** (in revision - en cours de révision)

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 réipients-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*

## 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*

## 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 manovacuumètres indicateurs et enregistreurs à élément récepteur élastique (instruments usuels)*

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

**R 109** (being printed - en cours de publication)

Pressure gauges and vacuum gauges with elastic sensing elements - Standard instruments

*Manomètres et vacuomètres à élément récepteur élastique - Instruments étalons*

**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

**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*

**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 intégreurs-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*

**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*

**D 22** 1991 80 FRF

Guide to portable instruments for assessing airborne pollutants arising from hazardous wastes  
*Guide sur les instruments portatifs pour l'évaluation des polluants contenus dans l'air en provenance des sites de décharge de déchets dangereux*

**PHYSICO-CHEMICAL MEASUREMENTS****MESURES PHYSICO-CHIMIQUES****R 14** 1979 - 1978 60 FRF

Polarimetric saccharimeters  
*Saccharimètres polarimétriques*

**R 54** 1981 60 FRF

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*

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



**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<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub> and Ar intended for the preparation of reference gas mixtures  
*Prescriptions pour les gaz purs CO, CO<sub>2</sub>, CH<sub>4</sub>, H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub> 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** (being printed - en cours de publication)

Refractometers for the measurement of the sugar content of fruit juices  
*Réfractomètres utilisés pour mesurer 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*

## 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*

## 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*
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- P 14** 1991 100 FRF  
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- 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*



# A perspective

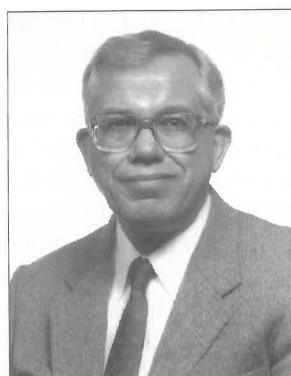
## LEGAL METROLOGY IN THE UNITED STATES OF AMERICA

**SAMUEL E. CHAPPELL** U.S.A. Member and Vice President of the International Committee of Legal Metrology

### THE AMERICAN WAY: A SYSTEM BASED ON COOPERATION

**I**N the United States, legal jurisdiction over weights and measures is a responsibility shared somewhat ambiguously by all levels of government: local, State, and Federal. The U.S. Constitution reserves to the States the right to regulate commerce and enforce the system of weights and measures within their boundaries and to the Federal government the power to regulate interstate commerce and "to fix the standard of weights and measures."

This U.S. system of legal metrology may appear to have the potential for intergovernmental conflict, disorganization, and disharmony. In the area of weights and measures, however, a long history of successful cooperation among the States and between the States and the Federal government has largely avoided conflict and achieved harmony and efficiency. In other areas involving the regulation of measurements and the regulation of measuring instruments themselves, intergovernmental cooperation has not been as well defined nor complete.



### OVERSIGHT OF LEGAL METROLOGY

In general, most weighing and measuring instruments and systems used in commerce are under the legal control of the States. Harmony among States in terms of regulations and practices is established through the National Conference on Weights and Measures (NCWM), a national organization of State and Federal weights and measures officials sponsored by the National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards. With technical assistance from NIST, NCWM develops model requirements for measuring instruments and systems, published as "Specifications, Tolerances and Other Technical Requirements for Commercial Weighing and Measuring Devices" in NIST Handbook 44. NCWM

also develops model weights and measures regulations, published as "Uniform Laws and Regulations" in NIST Handbook 130. These and other NCWM publications are intended to serve as the basis for State laws and regulations, as appropriate.

### REGULATORY ASPECTS IN THE UNITED STATES

Federal laws and regulations generally govern measurements and measuring instruments applicable to worker and public health and safety, and protection of the environment; they take precedence over State laws. Much of the regulatory responsibility in these areas actually falls to State agencies when State laws are at least as stringent as Federal requirements.

A few examples of Federal agencies prominently involved in the regulatory aspect of legal metrology are the Food and Drug Administration; the Food Safety and Inspection Service; the Federal Grain Inspection Service; the Federal Trade Commission; the Bureau of Alcohol, Tobacco, and Firearms; the Environmental Protection Agency; the Occupational Health and Safety Ad-



ministration; the Mine Safety and Health Administration; the National Highway Traffic and Safety Administration; and the Consumer Product Safety Commission. Many other Federal agencies purchase goods and services that require testing of products to determine conformity to specifications or performance requirements and, hence, are involved as consumers in the system of measurements and measuring instruments.

## THE LEADING ROLE OF NIST

The lead Federal role in U.S. legal metrology belongs to the National Institute of Standards and Technology, a non-regulatory agency of the Department of Commerce. NIST assists the States in technical matters and in harmonizing laws and regulations in weights and measures; it also assists Federal agencies, on request, in carrying out their regulatory responsibilities in areas of measurement. In brief, NIST is responsible for the following: (1) maintaining and developing the national physical standards of measurement; (2) developing certified reference materials for use in physical and chemical analysis in science and industry; (3) providing calibration services for measuring instruments, thereby establishing a mechanism for traceability of measurements to national standards; (4) conducting research in measurement science to assist other governmental agencies, science, commerce, and industry; and (5) fostering transfer of Federal technology to States and to the private sector.

NIST also maintains major links to international metrology by

providing representation and participation in the General Conference for Weights and Measures (Treaty of the Meter) and the International Organization of Legal Metrology (OIML). These links ensure compatibility of the U.S. national physical measurement standards with internationally defined and realized physical standards, and they establish a mechanism for channeling U.S. input and assistance into the effort of harmonizing the regulatory aspects of legal metrology on the international level. An analysis of the compatibility of U.S. national regulations with current OIML Recommendations is contained in the OIML publication concerning the national implementation and compatibility of Member States' regulations with OIML Recommendations.

## METROLOGICAL CONTROL

An important component of legal metrology is metrological control. This normally consists of pattern, or type, evaluation of measuring instruments and initial and sometimes subsequent verification. In the area of weights and measures, NIST cooperates with the NCWM to operate a National Type Evaluation Program. Subsequent verification falls under the purview of the States, as they deem appropriate.

In other areas of metrology, an efficient mechanism for metrological control is not so well defined, either at the Federal or the State level. In many instances, testing laboratories for measurement processes and instruments can be found in Federal, State, and private sector facilities. The competence of such laboratories

for testing and evaluations is often determined by an accrediting body which might be either governmental or private sector. For example, NIST operates the National Voluntary Laboratory Accreditation Program (NVLAP) used by both Federal agencies and private organizations for accrediting testing laboratories in specific areas of testing.

The National Conference of Standards Laboratories (NCSL) provides a forum for discussing calibration standards and has participation from governmental agencies as well as the private sector. The standards discussed are mainly secondary, transfer, and working standards used in industrial testing and reference laboratories. The NCSL was initiated by NIST but is now independent; however, NIST remains a vigorous participant in its activities.

## VOLUNTARY STANDARDS ACTIVITIES IN THE UNITED STATES

Another important component of legal metrology within the United States is the development of voluntary standards. Federal agencies are directed to participate in relevant standards developing organizations and, to the extent possible, to use the standards of these organizations in Federal regulations, product specifications, and other appropriate applications. A few hundred voluntary standards organizations exist in the United States. Examples of the most prominent are the American Society for Testing and Materials (ASTM), the American Society of Mechanical Engineers (ASME), the Institute of Electrical and Electronic Engineers (IEEE), the



Instrument Society of America (ISA), the Society of Automotive Engineers (SAE), the American Society of Civil Engineers (ASCE), and the National Fire Prevention Association (NFPA). The activities of these organizations are coordinated by the American National Standards Institute (ANSI), a private-sector organization, that also officially represents the United States in the International Organization for Standardization (ISO) and, through its U.S. National Committee, the International Electrotechnical Commission (IEC).

Some private sector testing and certification bodies develop codes

and standards with which products must conform or by which they are to be evaluated. Where matters of safety and health are of concern, such codes, standards, and conformance requirements are often written into Federal, State, and local laws and regulations.

### A SYSTEM REFLECTING THE CHANGING NEEDS OF THE US AND GLOBAL COMMUNITIES

The United States system of legal metrology is decentralized and

diverse. Its success depends on the cooperation of many unique entities that are held together in a loosely coordinated structure.

As would be suspected, this structure is constantly undergoing change in order to meet the needs and challenges of the State and Federal agencies involved. It reflects the needs of industry and the citizens in general with respect to equity in commerce, assurance of health and safety, and protection of the environment. In addition, it reflects the demands and challenges of the global community in all these areas.

## Presentations

### US President appoints new Director of NIST

Dr. Arati Prabhakar was appointed as the tenth Director of the US National Institute of Standards and Technology by President William Clinton and took office 28 May 1993. Previously, she served for seven years at the Defense Department's Advanced Research Projects Agency (ARPA), two years of which were served as the Director of the Microelectronics Technology Office.

As Director of NIST, Dr. Prabhakar manages the primary technology research agency of the Department of Commerce and the only federal laboratory explicitly charged with supporting U.S. industry.

With a staff of approximately 3,000, NIST pursues research, measurement, and standardization programs in physics, chemistry, materials, manufacturing engineering, electronics and electrical engineering, building and fire technology, computing and applied mathematics, and computer systems. NIST's mission also includes programs to assist industry in technology development and commercialization including the Advanced Technology Program, which supports industrial research in precompetitive generic technologies; the Manufacturing Extension Partnership, which aids the transfer of modern design and production techniques to small and mid-sized manufacturing firms, and the Quality Program, which supports the nationally recognized Malcolm Baldrige National Quality Award.

Dr. Prabhakar spent seven years at the Advanced Research Projects Agency managing research in advanced electronics. Her most recent activity was the creation of the Microelectronics Technology Office with the mission of research, development, and demonstration of advanced microelectronics technologies critical for national security, with an emphasis on dual-use technologies. She had strategic responsibility for programs in semiconductor manufacturing technology, including SEMATECH and advanced lithography. The overall

manufacturing programs were designed to stimulate and challenge the U.S. semiconductor industry to achieve cost-effective flexible manufacturing capability for high-value-added, differentiated products. Other areas of technology for which she was responsible included next-generation devices in optoelectronics, nano-electronics, and neural networks as well as flexible manufacturing and multispectral arrays for infrared focal plane arrays. While at ARPA, she worked in close partnership with industry, academia, and other national research laboratories. She managed one of the largest ARPA offices with an annual budget of \$300 million and contracts with many companies, including large electronics manufacturers, traditional defense contractors, small and mid-sized technology firms, universities, and other laboratories.



Dr. ARATI PRABHAKAR  
*Newly appointed Director of the  
United States National Institute of  
Standards and Technology*

Dr. Prabhakar served as a Congressional Fellow in the Office of Technology Assessment of the U.S. Congress from 1984 to 1986. At OTA, she conducted a study for the House Science, Research and Technology Subcommittee on Microelectronics Research and Development and participated in a study on intellectual property issues entitled *Intellectual Property in an Age of Electronics and Information*. While at the California Institute of Technology's

Department of Applied Physics, she served as a Research Fellow from 1979 to 1984 and as a Teaching Assistant from 1982 to 1984.

Dr. Prabhakar is a member of Eta Kappa Nu, Tau Beta Pi, the Institute of Electrical and Electronics Engineers, and the American Physical Society. She received a Congressional Office of Technology Assessment Science Fellowship as well as a fellowship from the Bell Laboratories Graduate Research Program for Women.

Born in New Delhi, India, Dr. Prabhakar received her B.S. in Electrical Engineering from Texas Tech University (1979), and her M.S. in Electrical Engineering (1980), and her Ph.D. in Applied Physics (1984) from the California Institute of Technology.



# Changing structures

## LEGAL METROLOGY IN CHINA TODAY AND TOMORROW

**BERNARD ATHANÉ** Director of the Bureau International de Métrologie Légale

**I**N the vast majority of domains, China is developing its participation in work that is performed through international cooperation. Fortunately, legal metrology has not been forgotten in these remarkable efforts: the ever-growing participation of Chinese experts in OIML activities, as well as China's initiatives for accepting responsibility for certain working groups such as acoustics, clearly mark this country's road to expansion.

### FROM PLANNED ECONOMY TO MARKET ECONOMY

The Chinese law for metrology \* which, for some time now, regulates the scientific and legal aspects of the discipline, was issued during an era when China was following the rules of a planned economy.

The recent orientation towards a market economy evokes the need for new interpretations of this law. Since 1987, the development of metrology has been based on four objectives:

- to publicize the law and to enrich the metrological

knowledge and legal conscience of the Chinese people;

- to improve the regulations applied by the law (type approvals, evaluations of the personnel charged with metrology in the enterprises, evaluation and control of measurement standards) and the establishment of necessary technical requirements; at present, 700 such requirements exist and will have to be divided into mandatory verification regulations and voluntary calibration provisions that will be applied by the enterprises;
- to build systems for supervision and metrological control at the district, municipal, provincial, and state levels; 2200 bodies have already been created and 30 000 people have been trained;
- to improve the technical means associated with metrology: there are approximately 2 400 calibration laboratories.

This transition from planned economy to market economy will also lead to the re-examination of the conditions in which the enterprises pursue their metrological activities: as in other countries with a market economy, the enterprises will be able to carry out verifications based on their own needs; moreover, they will be able to freely choose calibration laboratories among technical bodies having received the necessary accreditation.



*Li Chuangqing, Deputy Director General, State Bureau of Technical Supervision (SBTS); Bernard Athané, Director, BIML; Bai Jingzhong, Former Deputy Director General, SBTS.*

### LEGAL METROLOGY IN FULL EVOLUTION

The number of categories of instruments that are presently subjected to control is 111; this number, however, should be reduced in the future. These instruments cover four areas of application: commerce, health, security, and environment.

When the instruments in question are manufactured in China, they are subjected to the following controls:

- before the manufacture of an instrument: a pattern approval is carried out as well as the certification of the enterprise's aptitude for making instruments in conformity with the pattern;
- when an instrument is put into service: an on-the-spot verification is done at the expense of the user (therefore, there is no formal initial verification of the manufactured instruments);

\* The detailed regulations have been translated into German by Mr Liu Xinmin (Beijing) and Dr. R. Geller, Vice Director of the Bavarian Verification Administration; they can be purchased from DAM, Franz - Schrank - Str. 9, 80638 Munich, Germany.



- afterwards: instruments are subjected to supervision and periodical controls.

Foreign manufacturers might appear to have an advantage since they are not subject to the certification of aptitude; only the pattern approval is imposed on these manufacturers. The importer is responsible for verification when the instrument is put into service.

Generally, the State Bureau of Technical Supervision (SBTS) is responsible for the pattern approvals and the certification of aptitude. This agency uses the means and metrological expertise of other bodies for testing, particularly the National Institute of Metrology (NIM), which is the main laboratory in connection with the SBTS. The number of bodies authorized to carry out such tests, however, is increasing: about 30 bodies have been accredited in order to effect certain pattern approvals and certifications of aptitude.

Periodical controls are carried out by technical organizations that have been issued mandates by the State. For special instruments, the State issues mandates to bodies that are particularly concerned with verification: for example, to the Minister of Energy for electric energy meters and to societies dealing with the distribution of water and gas for water and gas meters. The supervision of instruments used in trade is effectuated by administrative bodies charged with metrology and periodical verification is carried out by technical bodies in metrology.

In addition, the law on metrology covers the uniformity of the values of quantities and measurement results: legal metrology applies therefore to the traceability of the instruments in

industry to the national measurement standards maintained by the NIM.

## A RAPIDLY DEVELOPING INTERNATIONAL COOPERATION: SUPPORT FOR REFORMS

This significant reform leading to a market economy in China will open the doors of a system that is applied by a number of its economic partners; the Chinese regulations for metrology illustrate the present situation which will evolve so they too will need to evolve in order to align themselves with those of other countries, thus developing exchanges between China and these countries.

In addition to bilateral cooperation, an increase in China's participation in OIML activities is judged appropriate by the SBTS authorities. National technical committees that correspond to OIML technical committees will be established to coordinate the participation of all Chinese bodies having an interest in OIML work. At present, three people at the SBTS are charged with the responsibility of following OIML work; the effective participation in this work is slowed down due to financial and linguistic problems for which solutions must be found.

## FOLLOWING IN THE FOOTSTEPS OF OIML AND OTHER INTERNATIONAL BODIES

Industrialists are encouraged to produce instruments that conform to OIML Recommendations and the use of OIML certificates will be developed.

Maximum permissible errors for instruments used in commerce will be adapted to the prices of the measured products based on the accuracy classes advocated by OIML.

This growing interest in OIML activities is developing in parallel to a wide re-positioning of China at the international level. For example, the accreditation of the calibration laboratories, which is now done according to national rules, will progressively be oriented towards accreditation in conformity with ISO and IEC provisions.

## A PROMISING FUTURE

Eight years after joining OIML, China's participation in the international cooperation for legal metrology is in a period of full expansion. My recent visit to Beijing was characterized by extremely fruitful exchanges with the new Assistant General Director of SBTS, Mr Li Chuangqing, who replaces the former CIML Member, Mr Bai Jingzhong.

Some fifty officials and scientists from SBTS, NIM, and other bodies attended a lecture on the new orientations of OIML activities. Visits to NIM, the Center for Reference Materials, and the Beijing Verification Office also provided the opportunity to multiply contacts with the Chinese metrologists.

At the end of this visit, the Chinese authorities clearly manifested their intention to pursue efforts that would lead to more active participation in OIML activities. BIML, for its part, will strive to continually provide information and assistance to the OIML Member States.



# Structures en transition

## LA MÉTROLOGIE LÉGALE EN CHINE AUJOURD'HUI ET DEMAIN

**BERNARD ATHANÉ** Directeur du Bureau International de Métrologie Légale

**D**ANS la plupart des domaines la Chine développe sa participation aux travaux de coopération internationale. La métrologie légale n'échappe heureusement pas à cet effort remarquable: la participation toujours croissante d'experts chinois aux travaux de l'OIML et même la prise de responsabilité de certains travaux (acoustique) est la marque de cette ouverture.

### DE L'ÉCONOMIE DE PLAN À L'ÉCONOMIE DE MARCHÉ

La loi chinoise sur la métrologie\*, qui depuis quelques années régit les aspects scientifiques et légaux de cette discipline, avait été promulguée à une époque où la Chine suivait encore les règles de l'économie de plan.

L'orientation récente vers l'économie de marché rend nécessaires des interprétations nouvelles de cette loi. Depuis six ans, le développement a été axé sur quatre domaines:

- faire connaître la loi et enrichir la connaissance métrologique

et la conscience légale du peuple chinois;

- améliorer les réglementations prises en application de la loi (approbation de modèle, évaluation du personnel chargé de la métrologie dans les entreprises, évaluation et contrôle des étalons) et établissement des règlements techniques nécessaires; il en existe actuellement 700, qui devront être divisés en règlements de vérification, obligatoires, et prescriptions d'étalonnage, volontairement appliqués par les entreprises;
- édifier un système de surveillance et de contrôle métrologique au niveau des districts, municipalités, provinces, et de l'État; 2 200 organes ont déjà été créés et 30 000 personnes formées;
- améliorer les moyens techniques: il y a environ 2 400 laboratoires d'étalonnage.

Ce passage de l'économie de plan à l'économie de marché va également conduire à réexaminer les conditions dans lesquelles les entreprises mènent leurs activités métrologiques: elles pourront, comme dans les autres pays développés à économie de marché, effectuer les vérifications selon leurs besoins réels. Par ailleurs, elles pourront librement choisir les laboratoires d'étalonnage, parmi des organes techniques ayant reçu les accréditations nécessaires.

### UNE MÉTROLOGIE LÉGALE EN PLEINE ÉVOLUTION

Le nombre de catégories d'instruments actuellement soumis au contrôle s'élève à 111, mais ce nombre devrait être réduit dans l'avenir. Ces instruments couvrent quatre domaines d'application: le commerce, la santé, la sécurité et l'environnement.

Les instruments en question, lorsqu'ils sont fabriqués en Chine, font l'objet des contrôles suivants:

- avant fabrication, une approbation de modèle et une certification de l'aptitude de l'entreprise à fabriquer des instruments conformes au modèle;
- à la mise en service, une vérification sur place, à la charge de l'utilisateur (il n'y a donc pas, à proprement parler, de vérification primitive des instruments fabriqués);



Propagande pour la métrologie

\* Les prescriptions détaillées ont été traduites en Allemand par M. Liu Xinmin (Pékin) et Dr. R. Geller, Directeur Adjoint de l'Administration Bavaroise de Vérification; cette publication peut être achetée au DAM, Franz - Schrank - Str. 9, 80638 Munich, Allemagne.



- ensuite, des contrôles périodiques et une surveillance.

Les constructeurs non chinois peuvent sembler avantagés par le fait qu'il est impossible de les soumettre à la certification d'aptitude; seule l'approbation de modèle leur est imposée; l'importateur est responsable de la vérification à la mise en service.

En règle générale, les approbations de modèle et la certification d'aptitude sont de la responsabilité du Bureau d'État de Supervision Technique (BEST) qui fait appel, pour les essais, aux moyens et à l'expertise métrologique d'autres organismes, en particulier l'Institut National de Métrologie (INM), laboratoire primaire organiquement dépendant du BEST. Cependant, une trentaine d'organismes ont été accrédités pour effectuer certaines approbations de modèle et certifications d'aptitude.

Des organisations techniques mandatées par l'État effectuent les contrôles périodiques et, pour certains instruments très spéciaux, l'État mandate des organismes particuliers concernés pour la vérification: ministère de l'énergie pour les compteurs électriques, sociétés de distribution d'eau et de gaz pour les compteurs d'eau et de gaz; la surveillance des instruments utilisés dans le commerce de détail sur les marchés est exercée par des organismes administratifs chargés de la métrologie et la vérification périodique est effectuée par des organes techniques de la métrologie.

La loi de métrologie couvre par ailleurs l'uniformité des valeurs des grandeurs et des mesures: la métrologie légale s'applique donc au raccordement des instruments de l'industrie aux étalons nationaux détenus par l'INM.

## UNE COOPÉRATION INTERNATIONALE EN RAPIDE DÉVELOPPEMENT: SOUTIEN AUX RÉFORMES

Cette profonde réforme conduisant à l'économie de marché va ouvrir à la Chine les portes d'un système appliqué par nombre de ses partenaires économiques; les réglementations chinoises en matière de métrologie traduisent une situation présente qui va évoluer: elles vont donc devoir évoluer elles aussi pour s'aligner sur celles des autres pays, permettant ainsi le développement des échanges entre la Chine et ces pays.

En plus de la coopération bilatérale, un accroissement de la participation de la Chine aux activités de l'OIML est jugé approprié par les autorités du BEST. Des comités techniques nationaux, correspondant aux comités techniques de l'OIML, vont être établis pour coordonner la participation de tous les organismes chinois concernés aux travaux de l'OIML d'intérêt pour eux. Actuellement, au BEST, trois personnes sont chargées de suivre les travaux de l'OIML et la participation effective à ces travaux est freinée par des problèmes à la fois financiers et linguistiques, auxquels des solutions devront être trouvées.

## SUR LES PAS DE L'OIML ET AUTRES INSTITUTIONS INTERNATIONALES

Les industriels seront encouragés à produire des instruments conformes aux Recommandations OIML et l'utilisation des certificats OIML sera développée. Les erreurs maximales tolérées des instruments utilisés pour le commerce seront adaptées aux

prix des produits mesurés, suivant le principe des classes de précision préconisées par l'OIML.

Cet intérêt croissant pour les activités de l'OIML se place dans un vaste cadre de positionnement de la Chine au plan international. Ainsi, l'accréditation des laboratoires d'étalonnage, qui se fait actuellement selon des règles nationales, va progressivement s'orienter vers une accréditation conforme aux dispositions de l'ISO et de la CEI.

## UN AVENIR PROMETTEUR

Huit ans après son adhésion à l'OIML, la participation de la Chine à la coopération internationale en matière de métrologie légale est donc en pleine expansion. Ma récente visite à Beijing a permis des échanges extrêmement fructueux avec le nouveau Directeur Général Adjoint du BEST, M. Li Chuangqing, qui remplace l'ancien Membre du CIML, M. Bai Jingzhong.

Une cinquantaine de fonctionnaires et scientifiques du BEST, de l'INM et d'autres organismes ont suivi un exposé sur les nouvelles orientations de l'activité de l'OIML. Des visites à l'INM, au Centre pour les Matériaux de Référence et au Bureau de Vérification de Beijing ont permis de multiplier les contacts avec les métrologues chinois.

En conclusion de cette visite, les responsables chinois ont clairement manifesté leur intention de réaliser les efforts permettant à la Chine de participer plus activement aux travaux de l'OIML. Le BIML, quant à lui, fera de son mieux pour intensifier l'information et l'assistance dont il peut faire bénéficier les États Membres de l'OIML.



# Quality assurance in medical laboratories

## SUPERVISION BY A VERIFICATION BOARD IN GERMANY

WALTER LUDWIG Eichdirektion Rheinland-Pfalz, Germany

**T**HE results of medical laboratory investigations form the basis of a great number of medical decisions. These measurement results must therefore be reliable and comparable.

In a medical laboratory, correct measuring instruments do not guarantee by themselves correct analysis results. Quality assurance must therefore cover not only the measuring instruments but also the methods of analysis, the reagents, the standards, and the handling of these.

### THE GERMAN EXPERIENCE

In Germany, requirements for the reliability of measurements are defined in the Verification Act. They are supplemented by rules governing quality assurance in medical laboratories which are edited by the Federal Medical Association. De jure, the Federal

Medical Association is a working pool of the Medical Associations of the Federal States of Germany. The Medical Associations are professional bodies, and at the regional level in Germany, they are corporations established by the law. The legislator has conferred upon them sovereign tasks which they carry out for their members within the scope of self-administration.

It is the task of the German verification authorities to supervise the medical laboratories for compliance with the regulations of the Verification Act and the rules of the Federal Medical Association.

In Rhineland-Palatinate, the Verification Board (supervising verification authority) with its subordinate verification offices in Bad Kreuznach, Kaiserslautern, Koblenz, Ludwigshafen and Trier is the authority responsible for the implementation of the regulations of the Verification Act.

### REGULATIONS UNDER THE VERIFICATION LAW

#### Verification ordinance

Whoever uses medical measuring instruments to carry out quantitative medical laboratory in-

vestigations has to supervise the measurement results by control checks (internal quality controls) and the participation in two comparison measurements (inter-comparisons) per year according to the rules of the Federal Medical Association. This person must preserve the records of the control checks as well as the certificates proving participation in intercomparisons for a period of five years; these records must be submitted on request to the competent authority.

This regulation entered into force on November 1, 1988. It is not applicable to examinations in the field of dentistry and veterinary medicine.

### Rules of the Federal Medical Association

The rules have been established in cooperation and in agreement with the Physikalisch-Technische Bundesanstalt.

For 47 measurands whose names are given, they provide:

- Statistical quality controls with precision and correctness control specimens and the preservation of control cards as internal laboratory measures.

- Participation in intercomparisons as external laboratory measures.

Among others, the following specialist associations offer intercomparisons:

- Institut für Standardisierung und Dokumentation im Medizinischen Laboratorium e.V. (Institute for Standardization and Documentation in the Medical Laboratory), and
- Deutsche Gesellschaft für Klinische Chemie e.V. (German Society for Clinical Chemistry).

## LABORATORY DUTIES REGARDING QUALITY ASSURANCE OF ANALYSIS RESULTS

According to the rules, the medical laboratories must check the reliability of their analysis results with a control specimen system by internal quality control and the participation in intercomparisons.

The laboratory's internal quality control, which has to be carried out by the laboratory staff, consists of precision controls and correctness controls.

A precision control is carried out daily to determine the daily dispersion of the analysis results of a precision control specimen. The analysis results are subjected to a graphical statistical test using a control card. This enables the examiner to immediately see whether the analytical system is still stable within the scope of the specified limits.

Special control specimens, whose concentration is not known, and

correctness control material of a known concentration can be used for the precision control.

The precision control requires that examinations be carried out beforehand to determine the laboratory's dispersion parameters; i.e. the control specimen is analysed on 20 different days. From the values measured, the mean value, standard deviation, and variation coefficient are then calculated.

The variation coefficient must not exceed a certain value; otherwise, the analysis system is not stable enough. In such a case, the causes must be determined and eliminated, and a new series of preliminary tests must be carried out in another preliminary period of 20 days. The mean value and the control limits calculated from the standard deviation (mean value plus and mean value less three times the standard deviation) are entered on the control card.

## CORRECTNESS CONTROL

In addition to the precision control, a correctness control is carried out. Within the scope of the correctness control, the results of an analysis of the correctness control specimen is compared with the associated location parameter. The location parameter is either a method-dependent target value or the reference method value for the measurand investigated. For certain measurands the comparison with the reference method value is prescribed. Reference method values are very good approximations to the "true value".

The maximum permissible percentage deviation of the individual result of the analysis of a correctness control specimen from the theoretical value or reference method value must not be greater than three times the maximum permissible relative daily dispersion of the analysis results.

Various correctness control specimens with concentrations in the normal range and outside the normal range (pathological range) are to be used.

The laboratory staff must keep records of the correctness and precision controls (lists with the calculations carried out and precision measurement values marked on the control card).

## INTERCOMPARISONS

In addition to the laboratory's internal correctness and precision controls, external correctness controls in the form of intercomparisons are prescribed in which every laboratory must participate at least twice yearly. For intercomparisons, specimens of unknown composition are forwarded to the laboratory by the organizer of the intercomparison. These specimens are analysed like a normal specimen from a patient, and the organizer of the intercomparison is informed of the result. After all results have been evaluated, all participants in the intercomparison receive a certificate stating the degree to which their analysis results fall within specified evaluation limits.



## TASKS OF THE VERIFICATION AUTHORITY

As the Verification Ordinance rigidly refers to the rules of the Federal Medical Association for quality assurance in medical laboratories, these rules become an integral part of a legal provision, i.e. an offence against them constitutes a breach of an administrative regulation and can be punished either by a warning and an on-the-spot fine for minor offences or by an administrative fine.

Germany's verification authorities have the task of controlling the medical laboratories to make sure that they abide by the rules in analyzing their test results.

## THE VERIFICATION AUTHORITY CHECKLIST BASED ON MANDATORY RECORDS KEPT BY THE MEDICAL LABORATORIES

### PRECISION CONTROL

- ✓ Preliminary tests have been carried out within a period of 20 days prior to the precision control.
- ✓ The specifications for compliance with the dispersion parameters (standard deviation or relative standard deviation) have been met.
- ✓ The values measured in the controls are recorded during the control period.
- ✓ These values are entered onto a control card.
- ✓ After one month or after performance of at least 15



Fig. 1 A check to see if a declaration of conformity for piston pipettes has been issued by the manufacturer

analyses, the mean value, the standard deviation and the relative standard deviation are calculated from the results obtained with the precision control specimens and checked for compliance with the specifications in accordance with the rules.

### CORRECTNESS CONTROL

- ✓ Control specimens with concentrations in the normal range and outside the normal range (pathological range) are used.
- ✓ The measurement values are listed and evaluated in accordance with the specifications for the maximum permissible deviation from the theoretical value or reference method value.
- ✓ The control measurement values are compared (according to the specification) with the method-dependent theoretical value or with the reference method value.

### PARTICIPATION IN INTERCOMPARISONS

- ✓ All parameters investigated in the laboratory are checked by intercomparisons at least twice per year.
- ✓ The appropriate certificates are available.

The authority also determines whether the measuring instruments in the laboratory comply with the requirements set forth by the verification ordinance (Fig. 1).

## SUPERVISION RESULTS OF THE VERIFICATION BOARD OF RHINELAND-PALATINATE

During the first six months of 1988, after the publication of the present rules, the Verification





Fig. 2 Evaluation of control results and documentation methods

Board of Rhineland-Palatinate polled hospitals in Rhineland-Palatinate. This written survey was intended to determine the state of the quality assurance measures in the hospital laboratories.

#### Sample questions:

*Is an internal quality control (precision and correctness control) carried out?*

*Is the control documented with quality control cards?*

*Is an external quality control carried out by participation in intercomparisons?*

Some results of the survey: 26 out of the 166 laboratories interviewed do not keep control cards for the precision control and 27 out of these 166 laboratories do not take part in intercomparisons.

Checks of the records of the control measures carried out have been performed by the Verification Board of Rhineland-Palatinate since 1990 in the

laboratories of hospitals, public health offices, and experts' agencies of the Regional Insurance Institution (Fig. 2).

For laboratories of general practitioners (doctors' laboratories), supervision is performed

by random sample survey using questionnaires. Experience gained since 1988 has led to more detailed questions in today's surveys which cover, for example, the dispersion parameters (mean value, standard deviation, and relative standard deviation) of the preliminary test period, the comparison of the control measurement values for correctness with a theoretical value or reference method value. Furthermore, the Verification Board requests the laboratories to submit the results for three analyses, which the laboratories may select themselves, i.e. to submit a relevant control card, a list of precision control values for the last two months, the record of the correctness control for one month, the instructions for using the control material, as well as the certificates proving participation in intercomparisons during the last 12 months.

The supervision results obtained have shown that more than 90 % of the laboratories of hospitals,

#### Main shortcomings in the observation of metrological rules

- ⇒ Only control specimens with concentrations in the normal range are used for the correctness control.
- ⇒ Within the scope of the correctness control, the measured values are not compared with the reference method value.
- ⇒ No precision control is carried out, i.e. there are no preliminary tests when the batch of control specimens is changed, nor is a graphical statistical test carried out using a control card.
- ⇒ Mean value, standard deviation, and relative standard deviation (variation coefficient) are not calculated at the end of one month which means that there is no check to determine whether the specifications of the rules are still respected.
- ⇒ After a series of preliminary tests have been carried out, the causes of large dispersions of the measurement values are not determined and eliminated.
- ⇒ During the control period, the dispersion of the measurement values is in some cases so large that the maximum permissible values established in the rules are greatly exceeded.
- ⇒ No precision control is made; instead, the values determined within the scope of the correctness control are entered onto a control card without another series of preliminary tests being carried out.



public health offices and experts' agencies of the Regional Insurance Institution do not meet the requirements established by the rules. In fact, none of the doctors' laboratories observe the rules and specified requirements (*see below*).

## ADVISE AND SUPERVISE

With a few exceptions, the quality assurance measures in medical laboratories are insufficient or even totally unsatisfactory. This conclusion would have to be made even if the rules of the Federal Medical Association that have been valid since 1988 did not exist.

According to today's state of the art, quality control of quantitative medical laboratory investigations must cover the control of both

precision and correctness. This condition, however, is not met in many laboratories.

Judging from the experience gained thus far by the Verification Board of Rhineland-Palatinate, the present unsatisfactory situation can be improved only if supervision by the verification authorities is intensified and adequate advice is given to those responsible for the laboratories. Almost all discussions in the laboratories have proved that the laboratory staff is highly interested in carrying out the quality assurance measures correctly.

In view of the high rate of complaints in Rhineland-Palatinate, the verification authorities of the other Federal departments in Germany have also become active since 1991. The results of the supervision work carried out there correspond to those obtained in Rhineland-Palatinate.

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# Measuring vehicle exhaust emission

## HUNGARIAN VERIFICATION BASED ON OIML RECOMMENDATION 99

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### LEGAL METROLOGY IN HUNGARY

past and present

**I**N Hungary, the metrological system has a long historical tradition

since the Austro-Hungarian Monarchy was one of the first members of the Meter Convention in the past century. The general technical development introduced a necessity to increase the fields of activity in which our scope is one of the newest. The gas analytical laboratory was established in 1978 with the aim of assuring metrological background for air quality measurements in environmental protection.

Nowadays, there are more and more sophisticated measuring instruments with very high precision and sensitivity for performing gas analytical measurements but most of them cannot achieve the desired accuracy without proper calibration or verification. The quality (i.e. reliability and comparability of the measured data) is strictly connected with the quality of the calibration procedure.

In the field of composition measurements, in most cases, the tools of this procedure are the Reference Materials (RMs) which, according to the Hungarian

Metrology Act XLV/1991, are equivalent to working standards in other well-known terminology.

Moreover, according to the above-mentioned law, all measurements that have legal consequences should be made by verified instruments or the instrument applied for such measurements must be controlled with working standards.

The exhaust gas control is a typical example for such official measurements; therefore, one of these two possibilities shall be applied.

### GASEOUS REFERENCE MATERIALS (GRMs)

working standards of gas analysis

Since 1978, the Hungarian Metrological Institute - National Office of Measures (OMH) has made efforts to develop the system of gaseous reference materials (GRMs) which ensures the traceability of measured data to the national and international standards.

The property realized by gaseous reference materials is the composition, i.e. the accurate value of the concentration of the component(s). The stability of the property defines the period during which the material is valid for reference purposes.

There are two possibilities for preparing gas mixtures of known composition:

- To produce mixtures by static methods (partial pressure, volume, or mass measurements) stored in pressurized conditions in cylinders or flasks.
- To blend mixtures continuously with proper blending equipment and with the required quantity for direct application.

In our terminology, gaseous reference material (GRM) refers to the first type of mixture.

The most accurate method of preparing gas mixtures is gravimetry: mixing pure gases under pressure in appropriate containers and measuring the mass of each constituent successively. This procedure needs a special and expensive instrumentation and carefully controlled experimental conditions. The result of the procedure is a gas mixture with a known mass fraction, or generally taking into account molar masses - mole fraction. These mixtures serve as *primary standard GRMs*.

The next step commonly used in the practice is the volumetric or partial pressure mixing where, according to the influence quantities (temperature, pressure, etc.), the concentration of the mixtures is more uncertain. The certification of these *secondary standard GRMs* by certification bodies is realized by comparison to



primary standards with the aid of highly sophisticated analytical instruments.

This procedure assures the traceability of stated composition values to the national measurement standards (in several countries such as Hungary, the first step of dissemination is realized by the national metrological authorities). In our country, the GRM system has been built up by the metrological institute (OMH) during recent years, in cooperation with technically well-equipped industrial plants (e.g. Messer-Griesheim Hungaria - MGH.)

Preparation of the primary standards and certification of the secondary ones is performed in OMH in all cases. The elements of the measuring system (instruments, other equipment including the measurement method) are under metrological control, i.e. their metrological characteristics are traced to national standards. The activity on the field of type approvals and verification is based on this GRM system.

## TYPE APPROVAL AND VERIFICATION OF GAS ANALYZERS BEFORE 1991

According to the Decree of the Government on Legal Metrology issued in 1976 (regulation before Hungarian Metrology Act XLV/1992), there are some cases in which it is compulsory to use either verified instruments or instruments that have been checked by working standards. A measuring instrument can be verified provided that a successful preliminary type approval has been performed by the metrological authority. In environmental gas analysis, the most commonly used measurement

was the type for the control of vehicle CO-emission. Exhaust CO analyzers working on the NDIR or catalytic combustion principle have been in use for several decades. In 1980, the gas analytical laboratory of OMH carried out the type approval of the most frequently used models immediately after the beginning of the active work. Among the tested instruments, a verification licence was issued for only two models of NDIR analyzers.

Main points in this decision:

- sufficient stability for infrequent (yearly) control,
- simple methods and tools for verification, and
- a great number of the type to be verified is in use.

The concentration range of these instruments was 0-10 % (V/V). The verification method applied three secondary type GRMs (CO-N<sub>2</sub>) and a CO<sub>2</sub>-N<sub>2</sub> mixture for the control of cross sensitivity. Work began in 1985 for compulsory verification, which was carried out by OMH regional offices and the concentration of the necessary GRMs was certified by the central gas analytical laboratory with a relative uncertainty of  $\pm 1$  %.

## OIML RECOMMENDATION IMPROVES TYPE APPROVAL

In the last two to three years, significant development has been made in the field of exhaust emission measuring instruments. In addition to detecting CO, the new types detect the residual HC, CO<sub>2</sub> as well. This sophisticated  $\mu$ p controlled analyzers offer the possibility for better motor diagnosis and setting, which is very useful for reducing both the air contamination and fuel consumption.

The **OIML Recommendation 99** came into force at the beginning of this development, with a different quality and series of investigations and has given very valuable support to performing the task. The system of metrological and technical requirements published in the Recommendation proved our former standpoint in many cases and helped solve new problems.

During this period of time, 24 type approvals and about 1000 initial verifications in this field were carried out at OMH.

### Distribution of type approvals according to manufacturing countries

|         |   |
|---------|---|
| England | 2 |
| France  | 2 |
| Germany | 4 |
| Italy   | 6 |
| Japan   | 4 |
| Sweden  | 1 |
| USA     | 4 |

Among the tested types, there were 14 instruments in class I and 10 in class II according to R 99 classification.

We have made a simplified type approval test. In our laboratory, we could not provide all the experimental conditions for the proposed investigations (e.g. damp heat or atmospheric pressure). It was also impossible to perform a great number of real exhaust-gas tests.

Our point of view was to determine the main metrological characteristics and to esteem the fulfillment of the main technical requirements (e.g. adjustment facilities, water separation, security of operation, etc).

For the metrological characteristics, we determined the calibration curve, the cross sensitivity, the drift, the thermal-influence (under normal humidity conditions), and the propane equivalency factor.

In the determination of the calibration curve, we applied a different method. Instead of three independent gas mixtures, we used only one of which the concentration was close to the upper end of the measurement range. Using this mixture and nitrogen or air, we made dilutions with a volumetric dilution pump system (Wösthoff M 21). The linearity, repeatability, and other metrological parameters of the former system were thoroughly tested.

We determined the calibration curve in ten points and calculated the absolute linearity error in each point. The diagram below

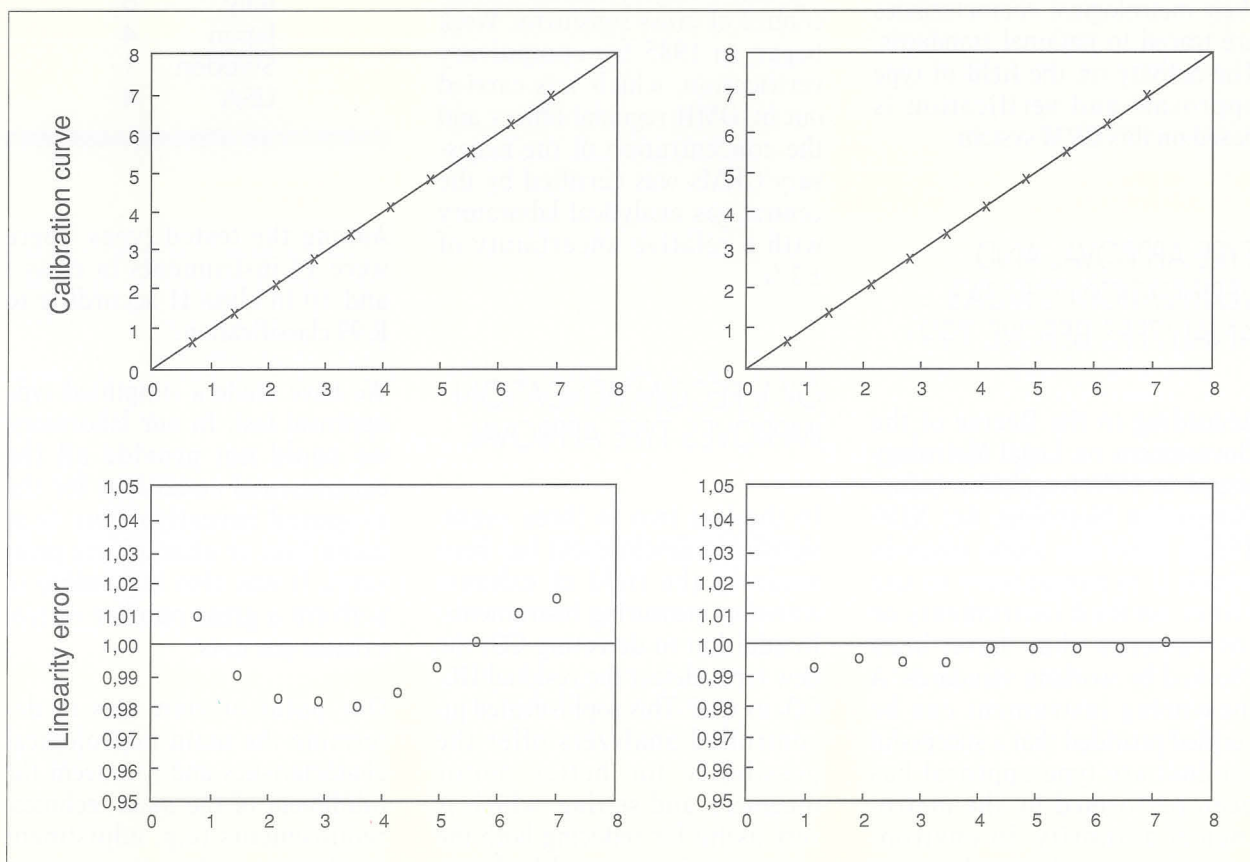
shows two examples for this method. The  $\pm 5\%$  maximum permissible error is shown in the diagram. The quality difference of the linearity of the two class I instruments is perceptible.

In our investigation, the metrological quality of each measuring channel had the same importance, which means that the requirements shall apply to the  $\text{CO}_2$  and  $\text{O}_2$  measurements as well. Although in official testing (the environmental control of vehicles) only CO and HC are involved, we extended the obligatory verification to include the  $\text{CO}_2$  measurement (as of 1 January 1992). The reason for this decision is that the magnitude of the  $\text{CO}_2$  concentration is the most important factor for the motor diagnosis and is also involved in other calculation. The verification of the  $\text{O}_2$  channel is not necessary

since the calibration of the detector for oxygen content in the air is always possible.

The methods and requirements of the initial and subsequent verifications are identical in Hungary. We use two different concentrations from multi-component gas mixtures and a  $\text{CO}_2\text{-N}_2$  mixture for control being the cross sensitivity. Until this time, the initial verification was also performed in the central gas analysis laboratory. As of next year, the verification activity will be transferred to the regional offices of OMH.

The verification of exhaust-gas analyzers is mandatory in many countries. The **OIML Recommendation 99** has given useful aid for developing unified methods and requirements for type approval and practical verification.



Examples of calibration curve and linearity error



# Monitoring pollutants

## EVALUATION OF PERFORMANCE CHARACTERISTICS FOR IN STACK OR AMBIENT AIR ANALYZERS



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**C**ONTINUOUS monitoring of various pollutants in ambient air or in stack emissions is increasingly used, especially to compare measured values with national or international regulations.

Due to this increase, users, authorities, and manufacturers have an interest in comparing performance characteristics and industrial use suitability of commercially available continuous monitoring systems (CMS). In the future, it will be useful to harmonize national test procedures.

### EVALUATION TESTS

Since a gas analyzer is usually only one component of a CMS, which may also include sampling probe, filters, conditioning unit, controlled temperature cabinet, and data pre-treatment, and since these other parts may have an influence on performance char-

acteristics, it would be better to undertake evaluation tests of the whole CMS, and not only of the analyzer. This is more realistic, but gives less general conclusions because suppliers often have to adapt their CMS to specific applications.

The best solution is probably to carry out evaluation tests simultaneously of a CMS designed for the more classical application, and of the analyzer alone. This does not induce much more work, and gives additional results, for instance, on pollutant losses occurring during gas pre-treatment. For regulation purposes, this provides the possibility certifying both the classical CMS and the analyzer, which can be used for other specific applications.

### POINTS TO CONSIDER

- Evaluation results are, of course, specific to the tested CMS or analyzer, which must be described very precisely. This is difficult for new devices which need important data processing (FTIR analyzers...) and are delivered with an associated computer, because their results may be strongly affected by calculation para-

meters (which can be easily modified by the supplier).

- Evaluation is usually carried out on only one device, which is considered representative of all devices of the same type. This is an optimistic view, and in fact it would be difficult to determine whether a failure occurring during tests is random or systematic. It would be better to test two identical devices simultaneously as in German procedures, which would require increased work but would permit one to compare results and determine internal reproducibility.

### DETERMINING PERFORMANCE CHARACTERISTICS

The purpose is to determine the extent to which measurements obtained by the CMS or the analyzer in industrial conditions are in agreement with true concentrations of pollutants in air or in stack gases. Since this agreement may be affected by many parameters that are not controlled on the industrial site, metrological tests are usually performed in well-defined laboratory conditions.

## Performance characteristics to be determined

### RANGE OF MEASUREMENT AND LINEARITY

Since users generally calibrate analyzers at two points (zero and one concentration), linearity is an important characteristic to check, although linearity criteria are difficult to define.

### ZERO AND SPAN INSTABILITY OR DRIFT

A very important point because CMS usually function 300 to 1000 hours between each calibration.

### LOWER DETECTION OR MEASUREMENT LIMIT

To quantify the uncertainty of measurements at low level concentration.

### CROSS SENSITIVITY

This point is of major interest because interferences by other components may especially affect measurements at low level concentration required by new regulations. For instance, for stack gas analysis, it seems necessary to check at least the influence of H<sub>2</sub>O (vapor), CO, CO<sub>2</sub>/O<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, and VOC (as CH<sub>4</sub> or C<sub>3</sub>H<sub>8</sub>). Other components may be checked, depending on specific applications and/or on detection principle used in the analyzer.

### RESPONSE TIME

This is not usually a critical point as it depends on the length of the sampling probe and sampling rate, measurement should be carried out for the analyzer alone and for the whole CMS.

### OTHER CONSIDERATIONS

Effects of ambient temperature, of sample pressure, of electrical power supply variations (voltage, short interruption), and of radio interferences may have strong practical consequences and must be checked.

In the above table, the most important points to be determined are indicated; they may be determined in well-defined, standardized conditions and therefore, results obtained on different CMS or analyzers tested at different times by different institutes may be compared.

## EVALUATING RELIABILITY AND MAINTENANCE REQUIREMENTS

The evaluation of reliability and maintenance requirements differs from the abovementioned

cases because laboratory conditions are not representative of site conditions. As these points are of prime interest for the user, they must be studied, installing CMS on site for about two months. Of course, results obtained during such tests may be affected by many uncontrolled parameters, and it is difficult to compare two CMS if tests are not conducted simultaneously on the same site. Although results are only indicative, experience shows that they may often be generalized and are very useful for users and manufacturers as they give information on:

- zero and span drifts by periodic calibrations,

- possible undetected cross sensitivity, by comparison with other measurement methods, and
- practical use problems (filter clogging, failures, etc.).

## WHAT EXPERIMENTAL PROCEDURE SHOULD BE USED?

Although there is a general agreement on the definition of performance characteristics (OIML R 99, ISO 6879), the standardization situation is less clear concerning the experimental procedure to be followed in order to determine the above-mentioned characteristics: in this field, OIML has not published an International Recommendation similar to those for vehicle exhaust emissions (OIML R 99).

If we only take into account international standardization (ISO, IEC), CMS and air or stack gas analyzers may be considered as:

- Gas analyzer, which is the field of ISO/TC 158, which adopted ISO 8158 "Evaluation of the performance characteristics of gas analyzers" in 1985.
- Air pollution measurement system: ISO/TC 146 is adopting several drafts, particularly ISO/DP 9169-2 "Air quality - Determination of performance characteristics of measurement methods", and also two specific drafts for SO<sub>2</sub> AND NO<sub>x</sub> emission monitors (ISO/DIS 7935, ISO/DP 10849-2).
- Process measurement and control devices: IEC/TC 65 B is working on a draft "General methods and procedures for evaluating the performances of process measurement and con-



trol devices" (in four parts), and IEC adopted CEI 770 "Methods of evaluating the performance of transmitters for use in industrial-process control systems" in 1984, which is used by some people to evaluate stack gas analyzers.

Although these texts have a similar philosophy, there are some differences between them and certain problems have not been solved. For instance, in order to determine linearity, which is an important characteristic, the ISO 9169-2 procedure uses a statistical data treatment which gives surprising results, often concluding that only unstable analyzers with high dispersed response are linear. Such conclusions are correct from a mathematical point of view, but have limited practical interest; it would be better to quantify the maximum nonlinearity error, and to compare it with a reasonable specification (for example 3, or 5 % of relative uncertainty).

Furthermore, as major problems which occur during on-site normal use are often related to long-term drift, interferences, or

influence quantities (for example, temperature), future standardization probably needs to give more consideration to these points (as does IEC 770) and to being less academic than ISO 9169-2.

### RECOGNIZING THE NEED FOR HARMONIZATION AND PROGRESS

There is undoubtedly a need for evaluating the performance of CMS used for ambient air or stack gas analysis: it is evident that in countries that have no official agreement or certification systems for such devices, users' associations (EXERA in France, WIB in Netherlands) have developed their own private evaluation system.

Experience often shows that evaluation is also very useful to manufacturers, especially for new devices, as it permits them to make final adjustments that improve reliability.

At the present time, each country has its own practice and requirements, thus evaluation tests must often be performed independently in each country. Therefore, international harmonization of evaluation procedures seems desirable. This has to be done by taking into account the real objective, which is not to obtain highly accurate measurements (for example, 10 %), but very reliable ones over long periods of time. Thus, it is not very helpful to determine precisely the value of a characteristic which is much better than that required, but it is essential to check as much as possible influence quantities which may vary on site.

If we need to be able to compare performances of different CMS, tested at different times by different institutes, all the tests have to be done in well-defined conditions, thus in laboratories. However, since an estimation of reliability is essential to ensure the credibility of the evaluation, and since this is not possible in laboratories, additional field tests must be carried out; their results, although only indicative, are often very useful.

# Eliminating technical barriers in commercial exchanges

## THE WEIGHT OF OIML RECOMMENDATIONS

**N**ATIONAL technical regulations give rise to certain barriers that hinder commercial exchanges (an expression which, at times, unfortunately masks protectionist tendencies). Harmonization of national regulations concerning measuring instruments is necessary in order to encourage free circulation of these products.

In this way, the need can be avoided for manufacturers to make different types of instruments specific to each country or group of countries. Uniformity of regulations also facilitates the movement of products and services whose commercial value is determined through measurement. One of OIML's principle responsibilities, therefore, is to

develop model metrological regulations which are published as "OIML Recommendations" and used by its Member States as the basis for their national regulations. These same Recommendations are also used by regional bodies such as the European Economic Community (EEC), the European Free Trade Association (EFTA) and COOMET.

Unfortunately, the implementation of OIML Recommendations through national regulations is slow, as shown by inquiries that are carried out by BIML every four years. At the European regional level, the development of Directives is also slow; at present, only nonautomatic weighing instruments have been the subject of a Directive and supplemented by a European Standard which is an exact reproduction of the OIML R 76-1 text.

### ACCELERATING HARMONIZATION WITH OIML RECOMMENDATIONS

One possibility of accelerating the harmonization of national regulations is to make direct reference to OIML Recommendations without developing the

corresponding regulatory texts. For example, in the framework of the Western European Legal Metrology Cooperation (WELMEC), the legal metrology authorities in the CEE and EFTA countries are developing a draft agreement through which a pattern having been tested and found to be in conformity with OIML requirements in one of the countries of the region will be accepted in the other countries (*see p. 52*). Initially, this agreement will be applied to automatic weighing instruments before being extended to include other categories of instruments.

Furthermore, after stating that French national regulations for gas meters had not yet been aligned with OIML Recommendations 6, 31, and 32, French authorities decided that meters in conformity with these Recommendations could, after testing, be approved even if they do not conform to the present national regulations.

These are examples of an approach that favors the development of international metrological cooperation based on OIML work; this approach also promotes the success of the OIML Certificate System whose application will soon be extended to cover more categories of instruments.



# Élimination des barrières aux échanges commerciaux

## LE POIDS DES RECOMMANDATIONS OIML

**L**ES réglementations techniques nationales créent des barrières qui freinent les échanges commerciaux (une expression qui malheureusement recouvre parfois des tendances protectionnistes). Dans le domaine des instruments de mesure, l'harmonisation des réglementations nationales est une nécessité pour permettre la libre circulation de ces produits.

Ainsi on pourra éviter aux constructeurs d'être obligés de fabriquer des modèles d'instruments spécifiques à chaque pays ou groupe de pays: l'uniformité des réglementations facilite également la circulation des produits et services dont la valeur marchande est déterminée à partir du mesurage. Une des principales responsabilités de l'OIML est ain-

si de développer des réglementations métrologiques modèles, publiées sous le nom de "Recommandations OIML" que les Etats Membres utilisent comme base de leurs réglementations nationales. Ces mêmes Recommandations sont également utilisées par des organismes régionaux comme la Communauté Economique Européenne, l'Association Européenne de Libre Echange ou COOMET.

Malheureusement cette mise en application des Recommandations OIML dans les réglementations nationales est lente, ainsi que le montrent les enquêtes effectuées tous les quatre ans par le BIML. Au niveau régional européen également, le développement des Directives est lent et seuls les instruments de pesage à fonctionnement non automatique ont fait l'objet d'une Directive complétée par une Norme Européenne qui reproduit exactement le texte de OIML R 76-1.

### ACCÉLÉRER L'HARMONISATION AVEC LES RECOMMANDATIONS OIML

Une possibilité d'accélérer l'harmonisation des réglementations nationales consiste à faire directement référence aux Recommandations OIML sans développer les

textes réglementaires correspondants. C'est ainsi par exemple que, dans le cadre de la *Western European Legal Metrology Cooperation (WELMEC)*, les responsables de métrologie légale des pays de la CEE et de l'EFTA développent un projet d'accord par lequel un modèle qui aura été essayé et trouvé conforme aux exigences OIML dans un des pays de la région sera accepté dans les autres pays (voir p. 52). Cet accord devrait initialement s'appliquer aux instruments de pesage à fonctionnement automatique avant d'être étendu à d'autres catégories d'instruments.

Les autorités françaises de leur côté, constatant que la réglementation en matière de compteurs de gaz n'avait pas encore été alignée sur les Recommandations 6, 31 et 32 de l'OIML, ont décidé que des compteurs conformes à ces Recommandations pourraient, après essais, recevoir une approbation même s'ils ne sont pas conformes à l'actuelle réglementation nationale.

Ce sont là des exemples d'un état d'esprit extrêmement prometteur pour le développement de la coopération métrologique internationale sur la base des travaux de l'OIML et pour le succès du Système de Certificats OIML, dont l'application va prochainement s'étendre à des catégories d'instruments toujours plus nombreuses.



## WELMEC AGREES TO RECOGNIZE CERTIFICATION OF CONFORMITY WITH OIML RECOMMENDATIONS

Completion of the single market in the various classes of automatic weighing instruments depends primarily on implementation of the new approach Measuring Instruments Directive. As this may take some considerable time, measuring instruments supporting an interim scheme, prepared in WELMEC, which is intended to minimize the time and cost of obtaining national type approvals in Europe.

The development of OIML Recommendations, together with test procedures and pattern evaluation report forms for each type of instrument, will generate a "common currency" of testing and a test result format that will be widely recognized. Each signatory to the WELMEC Agreement will accept from the other signatories national type approvals, supported by certificates of conformity with relevant OIML Recommendations, as the basis for issuing their own national type approvals. For non-metrological requirements, such as language and currency indications, the signatories will reserve the right to establish conformity with their own national requirements.

The work of harmonizing national regulations with OIML Recommendations is already in hand in the UK for those classes of instruments for which the OIML Recommendations are already published. In the meantime, the National Weights and Measures Laboratory (NWML) will, whenever possible, use the OIML Recommendations (or

latest drafts) in preference to the Design Assessment Guidelines which were previously the main criteria for judging compliance with regulations. This is to enable manufacturers to prepare for and take advantage of the new system as soon as possible, bearing in mind the length of equipment development time scales. Generally speaking, the main difference that will be seen in the practice of type examination is a greater emphasis on metrology and much less emphasis on peripheral functionality.

A number of countries in the EC and EFTA have indicated their intention to sign the WELMEC Agreement. To enable manufacturers to take advantage of the Agreement, NWML will issue certificates of conformity with OIML Recommendations on request where appropriate.

### COMPLETION OF OIML RECOMMENDATIONS

A draft Agreement to recognize OIML certification was discussed by WELMEC in January of this year and it is hoped that final agreement, involving at least some of the member states, will be reached in September 1993. Progress on the OIML Recommendations for automatic instruments is therefore crucial at this stage. NWML is currently responsible for OIML Recommendations for five classes of automatic weighing instruments in its capacity as secretariat of OIML SP 7-Sr 5.

The Recommendations for automatic rail-weighbridges (R 106), continuous totalizing automatic weighing instruments (R 50) and discontinuous totalizing automatic weighing instruments (R 107) are now completed. The test procedures and pattern evaluation report forms for these documents have been issued as drafts, with request for comments by 18 June 1993.

The sixth preliminary draft revision of R 61, automatic gravimetric filling instruments, was issued at end of March 1993, hopefully for agreement (by vote at secretariat level) by 11 June 1993.

The fourth pre-draft of R 51, automatic catchweighing instruments, was issued at end of March 1993. A significant change here is the proposal to treat weigh price labellers in the same way as other catchweighing instruments in that the limits of error will be specified in terms of the mean error and the standard deviation. A number of comments and proposed minor changes, notably from the UK industry at the National Working Group in May 1993, will be the subject of discussion at the International Working Group meeting at NWML in June 1993. The WELMEC secretariat hopes for agreement on this document by September 1993 and test procedures and report forms will follow as soon as possible.

#### Contact information:

National Weights and Measures Laboratory  
Stanton Avenue  
Teddington, Middlesex TW 11 0JZ  
United Kingdom  
Tel: 44 81 943 72 72  
Fax: 44 81 943 72 70





The *Organisation Internationale de Métrologie Légale* is expanding the scope of its activities in response to the evolutions in legal metrology.

Progress in OIML work will be published regularly in this section of the OIML Bulletin together with information pertaining to the general field of metrology.

L'*Organisation Internationale de Métrologie Légale* étend son domaine d'activité en réponse aux évolutions de la métrologie légale. Les progrès des travaux de l'OIML seront régulièrement publiés dans cette rubrique du Bulletin OIML, avec des informations relatives aux domaines généraux de métrologie.



Participants of the first meeting of OIML Technical Committee 8  
Wabern, Switzerland 28-29 June 1993

## TC 8

### Instruments for measuring quantities of fluids

Secretariat: Switzerland

Technical committee 8 (formerly Pilot Secretariats SP 5 and 6) held its first meeting in Wabern,

Switzerland 28-29 June 1993 with a view to establishing its subcommittees and work agenda.

**Chairman:** Mr Lerch,  
Office Fédéral de Métrologie,  
Switzerland.

**Participation:** 27 delegates representing 15 P-members; Alexandre Vichenkov from BIML.

#### MAIN POINTS

⇒ Unanimous decision to submit a proposal for the estab-

lishment of eight subcommittees:

- SC 1 Static volume measurement  
FRANCE
- SC 2 Static mass measurement  
AUSTRALIA
- SC 3 Dynamic volume measurement (liquids other than water)  
GERMANY
- SC 4 Dynamic mass measurement (liquids other than water)  
UNITED STATES OF AMERICA

- SC 5 Water meters  
UNITED KINGDOM
- SC 6 Measurement of cryogenic liquids  
UNITED STATES OF AMERICA
- SC 7 Gas metering  
BELGIUM
- SC 8 Gas meters  
NETHERLANDS

- ⇒ A recommendation was made for an agreement between the secretariats of the former and present structures as to the transition of work already in progress.
- ⇒ A visit to Endress + Hauser Flowtec AG at Reinach near Basel showed how modern meters for fluid flow are manufactured.

Contact information:

Mr Lerch  
Office Fédéral de Métrologie  
Lindenweg 50  
CH-3084 Wabern  
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Fax: 41 31 963 32 10  
Telegram: OFMET

## TC 8

### Instruments de mesure des quantités de fluides

Secrétariat: Suisse

Le comité technique 8 (anciennement secrétariats pilotes 5 et 6) a tenu sa première réunion à Wabern, Suisse les 28 et 29 juin 1993 pour établir ses sous-comités et son programme de travail.

**Président:** M. Lerch,  
Office Fédéral de Métrologie,  
Suisse.

**Participation:** 27 délégués représentant 15 membres-P; Alexandre Vichenkov du BIML.

#### POINTS PRINCIPAUX

- ⇒ Décision unanime de proposer l'établissement de huit sous-comités:

- SC 1 Mesurages statiques volumiques  
FRANCE
- SC 2 Mesurages statiques massiques  
AUSTRALIE
- SC 3 Mesurages dynamiques volumiques (liquides autres que l'eau)  
ALLEMAGNE
- SC 4 Mesurages dynamiques massiques (liquides autres que l'eau)  
ÉTATS-UNIS D'AMÉRIQUE
- SC 5 Compteurs d'eau  
ROYAUME-UNI
- SC 6 Mesurages de liquides cryogéniques  
ÉTATS-UNIS D'AMÉRIQUE
- SC 7 Mesurages de gaz  
BELGIQUE
- SC 8 Compteurs de gaz  
PAYS-BAS

- ⇒ Une recommandation a été faite en vue d'un accord entre les secrétariats des structures ancienne et nouvelle en ce qui concerne la transition des travaux en cours.

- ⇒ La visite de la maison Endress + Hauser Flowtec AG à Reinach près de Bâle a illustré la fabrication de compteurs modernes.

Contact pour information:

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CH-3084 Wabern  
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Fax: 41 31 963 32 10  
Telegram: OFMET

## TC 13

### Measuring instruments for acoustics and vibration

Secretariat: Germany

Technical committee 13 met in Oslo, Norway on 26 May 1993 in liaison with the IEC/TC 29 and ISO/TC43 meetings.

**Chairman:** Prof K. Brinkmann, Physikalisch-Technische Bundesanstalt, Germany.

**Participation:** 19 delegates representing 10 P-members, 2 O-members and 3 liaison institutions; K. Birkeland, General Director of the Metrology Service in Norway and CIML President; and B. Athané, Director of BIML.

#### MAIN POINTS

- ⇒ No subcommittee will be established for the time being and the activity of this TC will be based on the work of two ad hoc working groups:

WG 1 Sound meters  
China

WG 2 Audiometry  
Germany

- ⇒ Deadlines for the first committee drafts were fixed for the working groups; drafts will then be examined by TC 13.

- ⇒ Certain projects that were previously listed in the work program of SP 14 were either omitted or postponed to a later date.

- ⇒ Test methods and report for sound calibrators (OIML R 102) were approved.



- ⇒ TC 13 confirmed that, as far as possible, its activities would be based on IEC and/or ISO standards; close co-operation with ISO and IEC will be maintained so as to assure that the relevant standards are compatible with the specific needs of legal metrology.

Contact information:

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Director  
Physikalisch-Technische Bundesanstalt  
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## TC 13

# Instruments de mesure pour l'acoustique et les vibrations

## Secrétariat: Allemagne

Le comité technique 13 s'est réuni à Oslo, Norvège, le 26 mai 1993 en liaison avec les réunions CEI/TC 29 et ISO/TC 43.

**Président:** Prof. K. Brinkmann, PTB, Allemagne.

**Participation:** 19 délégués représentant 10 membres-P, 2 membres-O et 3 institutions en liaison; K. Birkeland, Directeur général du Service de Métrologie de Norvège et Président du CIML et B. Athané, Directeur du BIML.

### POINTS PRINCIPAUX

- ⇒ Aucun sous-comité ne sera pour l'instant établi et l'activité du TC sera basée sur les travaux de deux groupes de travail ad hoc:

WG 1 Sonomètres  
Chine

## WG 2 Audiométrie Allemagne

- ⇒ Des dates limites ont été fixées à ces groupes de travail pour produire les premiers projets de comité qui seront ensuite examinés par le TC 13.
- ⇒ Certains thèmes précédemment inscrits dans le programme de travail du SP14 ont été soit supprimés, soit reportés à une date ultérieure.
- ⇒ Les méthodes d'essai et le rapport d'essai pour les calibres acoustiques (OIML R 102) ont été approuvés.
- ⇒ Le TC 13 a confirmé que ses travaux continueraient à se dérouler, dans toute la mesure du possible, sur la base des Normes CEI et/ou ISO; le TC 13 maintiendra une coopération étroite avec l'ISO et la CEI pour assurer que les normes en question sont compatibles avec les besoins spécifiques de la métrologie légale.

Contact pour information:

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Physikalisch-Technische Bundesanstalt  
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38023 Braunschweig  
Tél: 49 531 592 80 10  
Fax: 49 531 592 80 15

## C I M L

The OIML International Committee of Legal Metrology held its 28th meeting in Berlin, Germany 4-6 October 1993. Details on the Committee's proceedings will be given in the **OIML BULLETIN** number 134 in January 1994.

*Le Comité international de Métrologie légale de l'OIML a tenu sa 28<sup>e</sup> réunion à Berlin en Allemagne du 4 au 6 Octobre 1993. Les détails sur les procédures du Comité seront publiés dans l'OIML BULLETIN numéro 134 de Janvier 1994.*

## i n f o

### Conference on Precision Electromagnetic Measurements

Boulder, Colorado, USA  
27 June - 1 July 1994

The 1994 Conference on Precision Electromagnetic Measurements will be held Monday 27 June to Friday 1 July 1994 in Boulder, Colorado, USA. The purpose of the biennial meetings of the CPEM is to exchange information on a wide range of topics on precise electromagnetic measurements. These topics include:

- Advanced instrumentation including new sensors and measurement methods
- Automated measurement methods
- Dielectric and antenna measurements
- Direct current and low-frequency measurements
- Fundamental constants and special standards
- Laser, optical fibre and optical electronic measurements
- RF, microwave and millimetre-wave measurements
- Superconducting and other low-temperature measurements
- Time and frequency measurements

Contact information:

Gwen E. Benett  
Conference Secretary  
National Institute of Standards and Technology  
325 Broadway  
Boulder, Colorado 80303, USA  
Tel: 1 303-497-3295  
Fax: 1 303-497-6461  
Telex: 910 940 5906





*Participants in the training course*

# Training course for the verification of weighing instruments

Munich, Germany  
3-13 August 1993

In view of the success of the 1991 and 1992 training courses organized by PTB at the German Academy for Metrology (DAM) in Munich and co-sponsored by OIML, a similar course was given 3-13 August 1993; it was very successful and well organized, with a well balanced program dividing the activities in two kinds: theory and practice (*see p. 58*).

The 21 participants from Bangladesh, Bulgaria, Czech Republic, Ecuador, Ghana, Jamaica, Kenya, Malawi, Mauritius, Mongolia, Nepal, Portugal, Romania, Senegal, Seychelles, Tanzania, Thailand, Tunisia, Uganda, Vietnam, and Zambia were selected from a large number of applications based on replies to a questionnaire; they all expressed their satisfaction at the end of the course.

BIML expresses its thanks to the organizers for the quality of this course, and the warm atmosphere

that favored a large participation of the group: welcome dinner, special Bavarian evening, excursion to the castle of Neuschwanstein, and city tours of Munich and Augsburg.

We thank the organizers of the training course: PTB (Mr Apel,

Miss Scholz), DAM (Mr Wallerus, Mr Rank, and Mr Seidl), and the lecturers: Mr Breuer (Director of the Bavarian Verification Administration), Mr Volkmann (PTB), Mr Reber (Mettler), Mr Biermann (Bizerba), Mr Barten (Pfister), Mr Källgren (SP) and Mr Thulin, former Assistant Director, BIML.



*Visit to the Munich Verification Office*



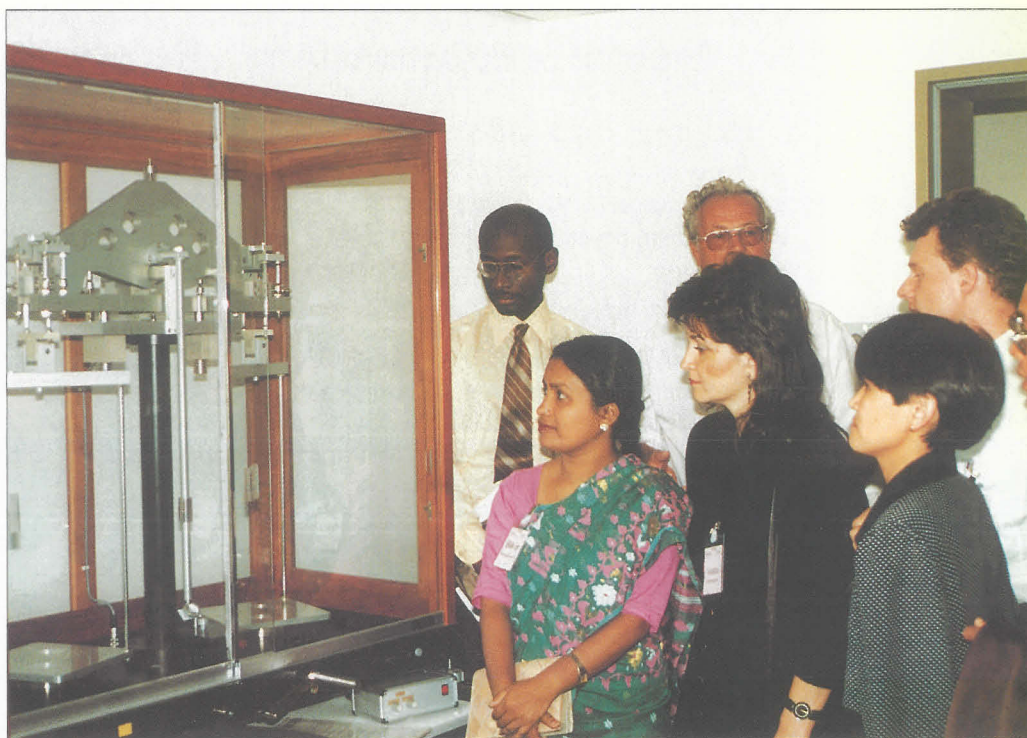
# Cours de formation pour la vérification des instruments de pesage

Munich, Allemagne  
3-13 Août 1993

Vu le succès des cours de formation organisés à Munich en 1991 et 1992 par la PTB à l'Académie allemande pour la métrologie (DAM) et co-sponsorisés par l'OIML, un cours similaire a été donné du 3 au 13 août 1993; la réussite de ce cours est due à l'organisation parfaite autour d'un programme équilibré répartissant les activités en deux catégories: théorie et pratique (*voir p. 58*).

Les 21 participants en provenance de Bangladesh, Bulgarie, Equateur, Ghana, Jamaïque, Kenya, Malawi, Maurice, Mongolie, Népal, Ouganda, Portugal, Roumanie, Sénégal, Seychelles, Tanzanie, République Tchèque, Thaïlande, Tunisie, Vietnam et Zambie, avaient été sélectionnés sur base d'un questionnaire distribué à un grand nombre de candidats; tous ont exprimé leur satisfaction à la fin du cours.

Le BIML exprime ses remerciements aux organisateurs pour la



Visite du Bureau de Vérification de Munich

qualité de ce cours ainsi que pour les moments de détente qui ont créé une ambiance amicale favorable à l'intégration de tous au sein du groupe: dîner de bienvenue, soirée bavaroise, excursion au château de Neuschwanstein et visites guidées de Munich et d'Augsburg.

Nous remercions les organisateurs du cours de formation: PTB (M. Apel, Mlle Scholz), DAM (M. Wallerus, M. Rank et M. Seidl), ainsi que les conférenciers: M. Breuer (Directeur de l'Administration Bavaroise de Vérification), M. Volkmann (PTB), M. Reber (Mettler), M. Biermann (Bizerba), M. Barten (Pfister), M. Källgren (SP) et M. Thulin, ancien Directeur Adjoint du BIML.



M. Breuer,  
Directeur de l'Administration Bavaroise  
de Vérification,  
conférencier du cours de formation  
pour la vérification  
des instruments de pesage



## Program of the training course for the verification of weighing instruments

### theory and practice

- OIML working procedures and OIML certification
- basic weighing principles
- visit to the Munich Verification Office
- review of OIML requirements concerning nonautomatic weighing instruments
- verification of nonautomatic weighing instruments
- verification of heavy test weights
- load measuring devices and load cells
- electromagnetic compensation devices
- classification of load cells
- information presented in a pattern approval certificate or an OIML certificate
- verification of class III retail scales
- calibration of heavy test weights (20 kg to 500 kg)
- lecture on the types and characteristics of mechanical vehicle scales
- review of various types of verification equipment of vehicle scales
- electronic static vehicle scales and hopper scales, characteristics and verification
- verification of mechanical vehicle scales up to 40 t
- verification of class II scales for pharmaceutical dispensing and jeweller trade
- on-site verification of an electronic vehicle scale
- review of principles and requirements for automatic industrial scales including in-motion weighbridges and beltweighers, combined with a visit of the Pfister factory in Augsburg

## Programme du cours de formation pour la vérification des instruments de pesage

### théorie et pratique

- méthodes de travail OIML et certification OIML
- principes de base du pesage
- visite du Bureau de vérification de Munich
- revue des prescriptions OIML relatives aux instruments de pesage à fonctionnement non automatique
- vérification des instruments de pesage à fonctionnement non automatique
- vérification des poids étalons de 20 kg et plus
- dispositifs mesureurs de charge et cellules de pesée
- dispositifs à compensation électromagnétique
- classification des cellules de pesée
- informations contenues dans un certificat d'approbation de modèle ou dans un certificat OIML
- vérification des balances de classe III utilisées pour le commerce de détail
- étalonnage des poids étalons de 20 kg à 500 kg
- exposés sur les types et caractéristiques de balances mécaniques pour véhicules
- revue des différents types d'équipement de vérification des balances pour véhicules
- instruments électroniques pour pesage statique de véhicules et totalisateurs discontinus à trémie, caractéristiques et vérification
- vérification des instruments mécaniques de pesage de véhicules jusqu'à 40 t
- vérification des balances de classe II utilisées en pharmacie et en joaillerie
- vérification sur place d'instruments électroniques de pesage de véhicules
- revue des principes et des prescriptions pour le pesage industriel automatique, y compris le pesage des trains en mouvement et les totalisateurs continus sur bande, combinée avec une visite de l'usine Pfister à Augsburg



## The OIML Certificate System moves forward... Developments and details



## Le Système de Certificats OIML avance... Développements et détails

**T**HE OIML Certificate System for Measuring Instruments was established in 1991 (see OIML Bulletin Number 122, March 1991) and is developing step by step: the first OIML certificate was issued at the end of 1992 and 12 others were registered during the first six months of 1993. All these certificates have been issued by the same issuing authority, the NMi in the Netherlands; however, in other countries such as Germany, United Kingdom, and China, manufacturers are now applying for OIML certificates (primarily for nonautomatic weighing instruments). The total number of OIML certificates should therefore grow significantly before the end of the year.

A complete list of these certificates will be published in the next issue of the OIML Bulletin. Periodically, lists of certificates issued since the previous publication and reports on the progress of the *Certificate System* will be published.

This information is important for anyone who uses OIML certificates, beginning with the legal metrology services: on a voluntary basis, they can take into consideration the OIML certificates and the annexed test reports in order to accelerate the processes of national type approvals.

At present, some interesting developments can be remarked: one country has already accepted to issue a type approval based solely on an OIML certificate and certain developing countries have decided to favor the importation of certified instruments. Finally, two OIML Member States are examining the possibility of concluding a mutual recognition agreement of test results given in the framework of OIML certification.

**E**TABLI en 1991 (voir Bulletin OIML numéro 122, mars 1991), le *Système de Certificats OIML pour les Instruments de Mesure* se développe pas à pas: le premier certificat OIML avait été délivré à la fin de 1992, et une douzaine d'autres certificats ont été enregistrés au cours des six premiers mois de 1993. Tous ces certificats ont été délivrés par la même autorité de délivrance, le NMi aux Pays-Bas; mais dans d'autres pays comme l'Allemagne, le Royaume-Uni ou la Chine, des constructeurs ont déposé des demandes de certificats OIML, principalement pour des instruments de pesage à fonctionnement non automatique. Le nombre total de certificats OIML devrait ainsi augmenter de manière significative d'ici la fin de l'année.

Une liste de tous ces certificats sera publiée dans le prochain Bulletin OIML. Périodiquement, des listes de certificats délivrés depuis le précédent numéro ainsi que des informations sur les progrès du *Système de Certificats* seront publiées.

Ces informations sont importantes pour tous ceux qui utilisent les certificats OIML, à commencer par les services de métrologie légale: ils peuvent, sur une base volontaire, prendre en considération les certificats OIML et les rapports d'essais qui leur sont attachés pour accélérer les procédures d'approbation de modèles nationales.

Des développements intéressants peuvent dès maintenant être signalés: un pays a déjà accepté de délivrer une approbation de modèle sur la seule base d'un certificat OIML et certains pays en développement ont décidé de favoriser l'importation d'instruments certifiés. Enfin, deux Etats Membres examinent la possibilité de conclure un accord de reconnaissance mutuelle des résultats d'essais donnés dans le cadre de la certification OIML.



## NEW MEASUREMENT LAW IN THE RUSSIAN FEDERATION

As of August 1993, a new law on the assurance of uniformity of measurement went into effect in the Russian Federation. More information will be published in the next issue of the OIML Bulletin.

Look for the calendar events and information on new publications in the January 1994 issue of the **OIML BULLETIN** Number 134.

## CORRESPONDENCE

### The error of errors

In the process of modernizing the concepts and applications of the expression of uncertainty in measurement, it would be helpful to abolish the term "error" in the sense of "deviation of a measuring instrument" or "deviation within limits to be estimated by the analysis of uncertainty". Until quite recently, the analysis of deviations in the results of measurements has been in the domain of mathematicians. In their view, physics is an exact science with exact quantities and relations between quantities. Therefore, their analysis starts with an exact quantity, the "true value" of the measurand. Any deviation in the result of a measurement is considered to be an "error". Their treatment is focused on the variable "errors" that permits the use of statistics. For metrologists, however, things are different.

The only facts with respect to our knowledge of a specific quantity we can lay our hands on are results of measurements of that quantity. The "true value" is something you can talk about, but you can never have it as a fact. Therefore, the concept of "a measurand", i. e. there is a unique and invariant quantity that is subject to the measurement, is sufficient.

"Error" in real life means that something has gone wrong, whereas the "errors" in metrology usually are within premeditated limits. Moreover, the deviations that can be treated with statistical methods (the type A evaluation) are the easy part. The most important parts of the craftsmanship of the measurement technician are to prevent considerable, unknown, "systematic" effects shown being present and to make a meaningful estimate of the unknown systematic effects, a type B evaluation, for the analysis of uncertainty.

The word "error" should be reserved for those situations in which something really has gone wrong; something beyond the limits of the analysis of uncertainty.

R. Muijlwijk  
NMI Van Swinden Laboratorium  
Delft, The Netherlands

## i n f o

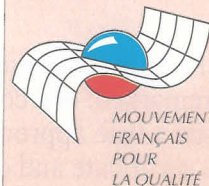
### Metrologie 93

Lille, France  
19-21 October 1993

Metrologie 93, an international congress sponsored by the *Collège de Métrologie du Mouvement Français pour la Qualité* and held in participation with the *Bureau National de Métrologie*, will address key metrological issues including quality in metrology, accreditation of metrology laboratories, environmental control of metrology laboratories, and standardization in metrology.

#### Contact information:

Secrétariat Métrologie 93  
Mouvement Français pour la Qualité  
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92733 Nanterre Cedex  
France



COLLEGE DE  
METROLOGIE

Reader views and reactions are appreciated. Please send correspondence to the Bureau International de Métrologie Légale, OIML Bulletin, Editorial Matters, 11 rue Turgot, 75009 Paris, France or fax to: 33 1 42 82 17 27. In order to be considered for publication, submissions must include a title, author's name, and contact information. The editors of the OIML Bulletin reserve the right to edit contributions for style and space restrictions.