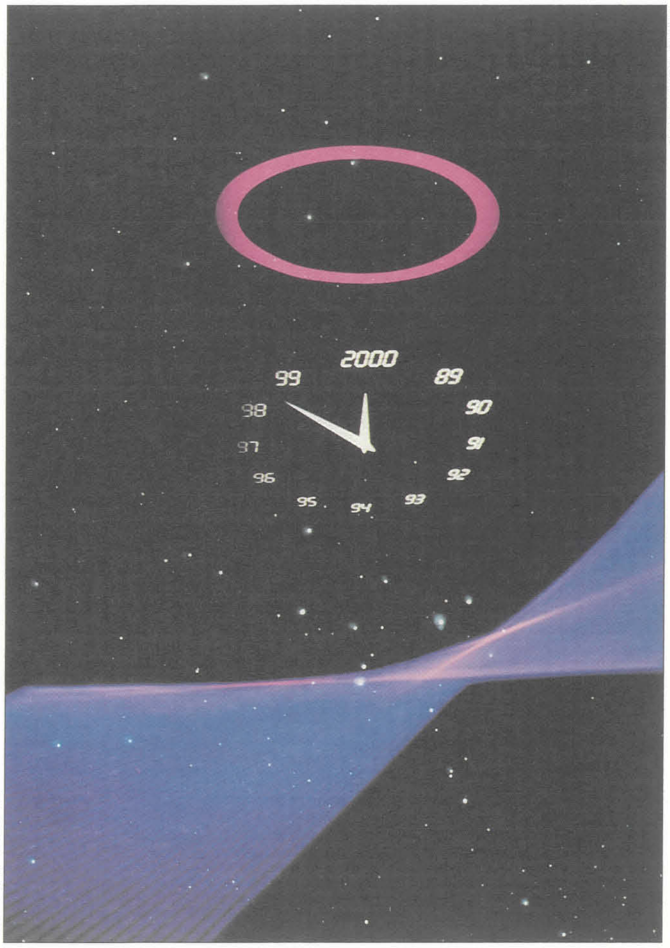
OIML BULLETIN

VOLUME XXXVI • NUMBER 2 • APRIL 1995

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

QUARTERLY JOURNAL



THE IMAGE BANK

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Towards the 21st century . . .

OIML approaches the future with new long-term policy orientations

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

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

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OIML BULLETIN

VOLUME XXXVI • NUMBER 2 • APRIL 1995

technique

evolutions

Since the beginning of the 1990's, the definition of new policy directions for OIML has been one of the Organization's most important activities. This issue of the Bulletin features two parts of a long-term policy document with three modules addressing metrology and its various aspects, OIML as it appears today, and the strategies to be followed by OIML for accomplishing its goals. In the Editorial, B. Athané, Director of BIML, explains the context in which the *Long-term policy of OIML* was developed.

update

OIML ENTERS A NEW CENTURY WITH A REDEFINED LONG-TERM POLICY.

PAGE 24

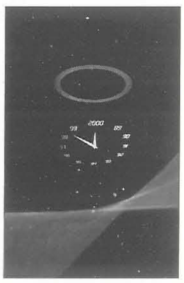

Photo by Sergio Duarte

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OIML BULLETIN

VOLUME XXXVI • NUMÉRO 2 • AVRIL 1995

technique

évolutions

Dès le début des années quatre-vingt-dix, l'une des plus importantes activités de l'OIML a été de définir les nouvelles directions de sa politique. Le présent numéro du Bulletin présente deux des trois parties d'un document qui traite de la métrologie sous ses divers aspects, de l'OIML telle qu'elle apparaît aujourd'hui, et de la stratégie que l'OIML doit appliquer pour atteindre ses objectifs. Dans son éditorial, B. Athané, Directeur du BIML, explique le contexte dans lequel la *Politique à long terme de l'OIML* a été développée.

d'un bulletin à l'autre

Editorial

In the January 1995 issue of the OIML Bulletin, our newly-elected President, Gerard J. Faber, introduced *a new strategy concept* for the future of OIML.

Several years of thoughts and discussions within the OIML Conference and Committee were concluded in a recent two-day meeting of the Presidential Council, during which the text of the OIML long-term policy and strategy paper was finalized.

In fact, what do we mean by *new?*

Obviously, the basic aims of OIML, as defined by the statutory *Convention,* have not been questioned, but just reaffirmed. Obviously, the *raison d'être* of legal metrology and its international harmonization appear as they did when OIML was established, although strengthened by the evolutions of our world.

In this sense, the OIML long-term policy paper will perhaps disappoint those who were expecting revolutionary views on legal metrology: after years of discussions, it was concluded that international legal metrology deserved sound evolutions, not an abrupt revolution.

What is new is the spirit in which OIML Members have considered the situation, and decided to express, in written form, a consensual result of what they had on their minds.

What is new is the effort to maintain transparency in OIML activities so that all those interested in participating in our work or in implementing our output know exactly what we do and how we do it.

What is new is the clear list of actions that will be pursued for reaching OIML's goals.

What is new is the assessment procedure that will permit CIML to monitor progress and redirect strategy actions whenever necessary.

What is new is OIML's reinforced willingness to participate actively and in close cooperation with numerous international and regional bodies to promote metrology, in all its aspects, as an essential tool for progress and welfare.

The OIML long-term policy paper includes three parts. Parts 1 and 3 are given in this issue of the Bulletin; Part 2 is a current description of OIML and is not reproduced since such information has already been published in previous issues of the Bulletin.

I invite all those interested in metrology, and especially in legal metrology, to share their reactions with us after having read these two essential parts of OIML's policy (pp. 24–29 for the English version and pp. 30–35 for the French version). All comments, favorable or critical, will no doubt encourage us and assist us in choosing the best orientations for our activity.

B. Athané

B. Athané

ENVIRONMENTAL MEASUREMENT TECHNOLOGY

Fabry-Perot correlation photometer for gas analysis*

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Abstract

The spectral correlation methods have obtained great importance in industrial gas analysis. A Fabry-Perot correlation photometer using a newly developed, thermally-tuneable silicon etalon is introduced. After a short presentation of the fundamentals, the paper describes the concept, construction and application possibilities of the photometer. Based on the exemplary measured components CO and NO, the features of the photometer are examined with emphasis on the selectivity. Finally, the relevant properties are compared with those of the NDIR correlation method.

1 Introduction

In process and environmental measurement technology, the concentration of certain gases must be monitored or regulated. For example, an important field of application is the flue gas monitoring of the components CO, NO, NO_2, SO_2, CO_2, and HCl. Such applications presuppose that the component of interest is determined in the gaseous mixture with the necessary degree of selectivity and sensitivity, without other components falsifying the measurement. Here, special correlation methods have attained significant importance for practical applications.

Correlation methods operate on the principle that the absorption spectra of low molecular organic gases possess a pronounced, fine structure in the IR and UV spectral region, this feature being a characteristic of the respective gas [1–3]. The basic idea is to compare the absorption spectra of the examined gaseous mixture with that of the gas component to be detected (measured component) and then to determine a quantitative measure for the "similarity" of both spectra. Well-known procedures are the gas-filter correlation [4], the non-dispersive infrared method [5], and two different interferometric correlation methods based either on the multiple-beam interference [6–8] or on the two-beam interference [9–11]. The multiple-beam interference method uses a Fabry-Perot interferometer [12] which simulates the absorption spectrum of the measured component and saves it in the measuring instrument. To date, very little has been published on the practical application of the Fabry-Perot correlation method [6–8], most likely due to the complex design and operation of the Fabry-Perot interferometer known up to now.

The following article focuses on a Fabry-Perot correlation photometer featuring a newly designed, electrically conductive silicon etalon [13, 14]. The fundamentals and concept of a laboratory prototype as well as the possible applications of the photometer will be outlined.

2 Fabry-Perot correlation method

Figure 1 illustrates the design and operating method of the classical Fabry-Perot interferometer. A plane-parallel layer of air is confined by two glass plates (P1 and P2). Both plates are provided with semitransparent mirrors on their inner sides; at present, dielectric mirrors permitting low-loss transmission of light are generally used [15]. An optical beam emitted from the light source is frequently reflected to and fro once it has penetrated the mirror layer of the first plate. A fraction of the energy is emitted towards the back during each reflection. To prevent interfering reflections on both external surfaces of the glass plates, the latter are slightly wedge-shaped. The optical beams coming from

(*) *Translated from the original German version published in tm - Technisches Messen 5/1994.*

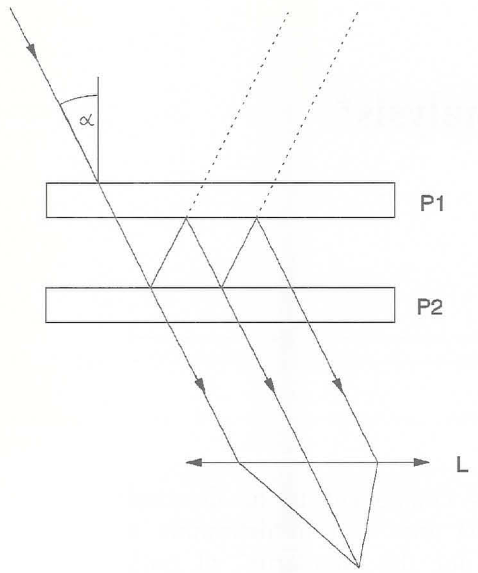

Fig. 1 Schematic diagram of the classical Fabry-Perot interferometer. P1 and P2: mutually plane-parallel plates, L: lens, ∝: angle of refraction. Typically, the inner sides of the plates feature semitransparent mirrors with a reflectance of approx. 0.9–0.95.

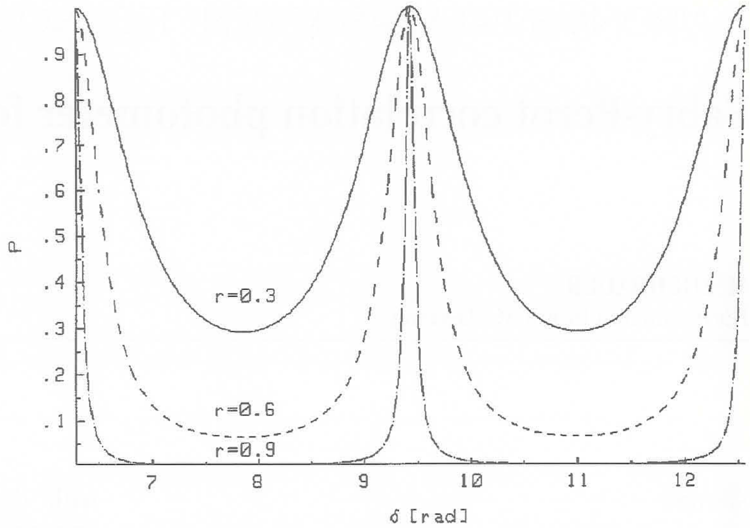

Fig. 2 Illustration of the Fabry-Perot transmission

$$P(\lambda) = \frac{t^2}{(1-r)^2} \cdot \frac{1}{1 + \frac{4r}{(1-r)^2} \sin^2 \left(\frac{2\pi sn \cos\alpha}{\lambda}\right)}$$

as a function of the phase angle δ. $\delta = (2\pi sn\cos\alpha)/\lambda$ for different reflectances r (t: transmittance; s: space between plates; n: refractive index; ∝: light refraction angle; λ: wavelength).

the second plate interfere with each other and are combined in the focal plane of a lens L. Using an adjustment device, the distance between P1 and P2 (hence the optical layer thickness) is set to a certain value. The illustrated arrangement can be simplified if the adjustment tasks for the distance between the plates can be dispensed with. In this case, only one plate, which is plane-parallel and coated with semitransparent mirrors on both sides, is used. This shape of the Fabry-Perot interferometer is generally designated as an etalon and is used here (see section 4). Maximum light amplification is observed when the optical layer thickness (twice the distance between the mirrors) is equal to an integer multipled by the light wavelength.

The transmission of a Fabry-Perot interferometer as a function of the wavelength is calculated from the Airy function (Fig. 2). Two essential features of the Airy function can be observed: the transmission peaks are equidistant with respect to δ, the curve shape is dependent on the reflectance r. The distance between the transmission peaks is designated as the free spectral range. Another vital characteristic of the Fabry-Perot interferometer is its narrowness, which is defined as the ratio of the free spectral range to the half-intensity width of the Airy profile.

The principle of the Fabry-Perot correlation method can be demonstrated on the basis of a special correlation function, which gives a measure of the similarity between the Fabry-Perot spectrum and the sample gas spectrum. The correlation function [14] is expressed as

$$\Gamma(\sigma) = \frac{1}{K_N} \int_0^\infty F(\nu)[1 - T(\nu)]P(\sigma,\nu)d\nu \qquad (1)$$

where σ is the free spectral range of the Fabry-Perot, ν is the wave number (reciprocal value of the wavelength), F(ν) is a filter function, $T(\nu)$ is the transmission spectrum of the gaseous mixture and P(ν,σ) is the Airy function.

The function

$$K_N(\sigma) = \int_0^\infty F(\nu)P(\sigma,\nu)d\nu \qquad (2)$$

is used for normalization. In the simplest case, the gaseous mixture (sample gas) comprises only the measured component. As an example, Fig. 3 shows a transmission spectrum of CO. The free spectral range, i.e. the optical layer thickness, is set such that the distance between the interference lines is equal to that between the rotational lines of the CO spectrum. The correlation function shown in Fig. 4 is obtained by changing the free spectral range.

The correlation function indicates an oscillating course with relatively sharp maximum values for CO. The left maximum value with the highest amplitude

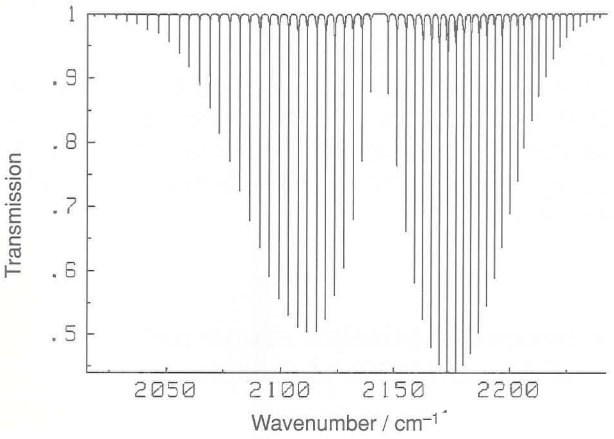

Fig. 3 Numerically calculated transmission spectrum of CO as a function of the wavenumber [16–18]. The line calculation is based on the Lorentz function. Concentration $c = 10^{-3}$ bar, cell length l = 13 cm.

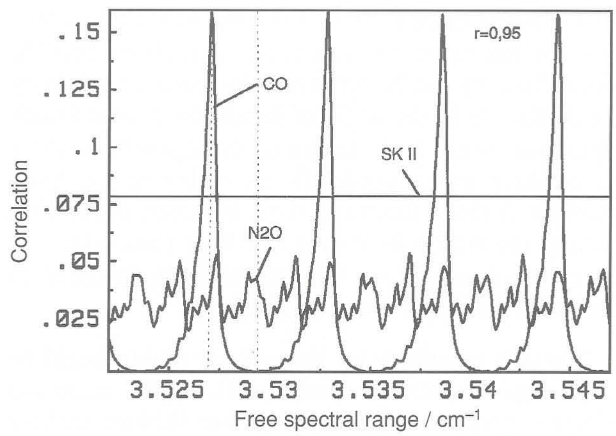

Fig. 4 Correlation function as a function of the free spectral range for CO, for the structured absorbing interfering component N_2O as well as an assumed wideband absorbing interfering component (SKII). The reflectance r = 0.95 corresponds to the narrowness N_r = 61.2. Filter function: ν_z = 2174.5 cm^{-1} (center of the R-branch of the CO band), $\Delta\nu$ = 50 cm^{-1}. Interfering component II: Gaussian function with ν_z = 2125 cm^{-1}, $\Delta\nu$ = 300 cm^{-1}.

corresponds to the resonance position, i.e. the state where interference lines and rotational lines coincide. However, the coincidence is not strict since the interference lines are equidistant, whereas the rotational lines are not. The correlation minimum value which follows can be viewed as the antiresonance position, i.e. where the interference lines and rotational lines are mutually phase-shifted by a distance of half a line. The degree of correlation is practically zero in this state. The next correlation maximum value is observed if the Airy function is displaced by exactly one interference order. The slowly declining amplitude of the correlation maximum values results from the decreasing coincidence between interference and gas lines.

Completely different conditions arise depending on whether one observes the correlation function of individual interfering components, e.g. nitrous oxide (N_2O), whose pronounced rotation-vibrational spectrum partially intersects the CO spectrum, or whether one studies a wideband, non-structured interfering component. The correlation functions calculated can be seen in Fig. 4.

Unlike the measured component CO, a significantly reduced correlation contrast can be observed for both interfering components, with this being practically zero in the case of the wideband interfering component. The correlation method's ability to suppress interfering components can be easily demonstrated by calculating the difference between the degree of correlation of the resonance and antiresonance positions for the respective components (broken lines in Fig. 4). The sensitivity is zero for the wideband interfering component. The degree of correlation for nitrous oxide in the resonance and antiresonance position is of practically the same magnitude, thus resulting in fairly satisfactory compensation. However, such favorable circumstances do not always exist for practical applications; more difficult cases will be discussed in section 5.

3 Concept of the tuneable Fabry-Perot interferometer

The fundamental aim is to simplify the complicated mirror adjustment for the classical Fabry-Perot interferometer. The solution is obvious: if the Fabry-Perot interferometer is designed as an etalon consisting of a single plate with semitransparent mirrors on the boundary surfaces, the mirror adjustment is fully omitted. Of course, we have to obtain the same degree of parallelism of the mirror surfaces for the etalon; however, adjustment for this is already made at the time of manufacture, e.g. by means of smoothing and polishing. Once the etalon surfaces have been mutually aligned, they remain in this position and need not be permanently checked during operation.

From the Airy function (Fig. 2), one can deduce that tuning can only be performed via the refractive index n, thickness s or the angle of refraction α. As regards the angle of refraction α, attention is called to the change that must be made in order to displace the interference lines by one order. The calculation [14] shows that the desired tuning can be performed by making a relatively small change in the angle of incidence. A conceivable approach would be to obtain an arrangement using a step motor which would tilt the etalon in a defined manner. A more thorough view, however, shows that tuning the etalon by means of tilting results in very stringent demands on the optical setup in order to maintain the narrowness during tuning.

The next possibility for Fabry-Perot tuning would be to change the refractive index n. Here, one could use electro-optical crystal materials. For lithium niobate (n = 2.2, s = 624 µm, λ = 4.6 µm), one needs a control voltage of 14.4 kV for displacing the interference lines by one order ($\Delta n = 3.7 \cdot 10^{-3}$ [14, 19]). The high voltage needed results in relatively complicated electronic circuits which make the use of the etalon difficult, if not impossible. Acoustico-optical crystals also permit tuning by changing the refractive index. For example, TeO_2, features the highest acoustico-optical effect which is based on the photoelastic effect. Using the relatively high, but technically feasible acoustic power of 100 W/cm², the refractive index variation $\Delta n = 6.2 \cdot 10^{-4}$ [19] is obtained, hence only approximately 1/6 of the desired value. Therefore, acoustico-optical crystals are not suitable.

Finally, thermal tuning can be considered as a "trivial" possibility, with both the thickness s as well as the refraction index n being changed. In this case, the optical layer thickness $s \cdot n$ is the variable to be tuned. The temperature difference of the displacement by one interference order is

$$\Delta T_\sigma = \frac{\lambda \cdot \sigma \cdot n}{\dfrac{d(s \cdot n)}{dT \cdot s}}, \qquad (3)$$

where $d(s{\cdot}n)/(dT{\cdot}s)$ denotes the temperature coefficient of the optical layer thickness. Table 1 shows that the temperature difference, e.g. for silicon and germanium, is relatively small. Therefore, in principle there are no objections to experimental implementation.

This gives rise to the question as to whether it is possible to construct a simple thermally-tuneable etalon with a small mass, capable of operating without an external thermostat of slow response and suitable for quick measurements. It would have to be possible to heat the etalon "directly" in order to keep the total mass to a minimum. The etalon concept implemented here is therefore based on the use of an electrically conductive etalon material which can be heated in a defined manner by direct application of a relatively low electrical voltage [25]. The fact that the two materials with the lowest temperature difference (silicon and germanium – see Table 1) are also semiconductive materials must be viewed as a favorable circumstance. Both materials can be easily doped and set to the desired electrical conductivity. Silicon was ultimately chosen because it can be well-processed by using thin-film technology.

4 Design and principle of operation of the correlation photometer

Figure 5 illustrates the design of the thermally tuneable silicon etalon. It consists of a silicon plate P with the dimensions 11 × 11 mm². The silicon material used has the crystal orientation < 100 > and is p-doped with a surface resistance of approximately 1–10 Ω·cm. Depending on the measurement task, the plate thickness is chosen such that the distance between the interference lines is equal to the distance between the rotational lines. For example, a thickness of approximately 400 µm is obtained for the CO measurement.

The thermally-tuneable silicon etalon is designed using thin-film technology (sputtering technology) in the following manner. The gold-electrodes E1 and E2 are arranged on two opposite edges, and are connected electrically with the silicon via a bonding layer H (e.g. nickel). The electrodes are used for applying an electrical voltage (approximately 40–50 V) which drives a current through the plate and warms it. A nickel resistor T, which is electrically isolated from the silicon by means of the thin silicon nitride insulation layer I, is situated on plate P for precise temperature measurement. The gold surfaces K have been provided

Table 1 Temperature coefficient of the optical layer thickness $d(sn)/(dTs)$ and temperature difference for displacement by one free spectral range ΔT_σ in the case of CO measurement for various crystals and glasses [20–24]. The calculation of the values in the right column is based on the free spectral range 3.5 cm⁻¹ and on the wavelength 4.6 µm.

Material	$d(sn)/(dTs)$ [1/K]	ΔT_σ for CO [1/K]
CaF_2	$27.8\ 10^{-6}$	198.6
ZnS	$53.3\ 10^{-6}$	103.6
ZnSe	$80.0\ 10^{-6}$	69.0
CdTe	$110.9\ 10^{-6}$	49.8
GaAs	$167.2\ 10^{-6}$	33.0
Si	$174.2\ 10^{-6}$	31.8
Ge	$419.4\ 10^{-6}$	15.4
Quartz	$10.7\ 10^{-6}$	516.2
IRG 100	$95.3\ 10^{-6}$	58.0

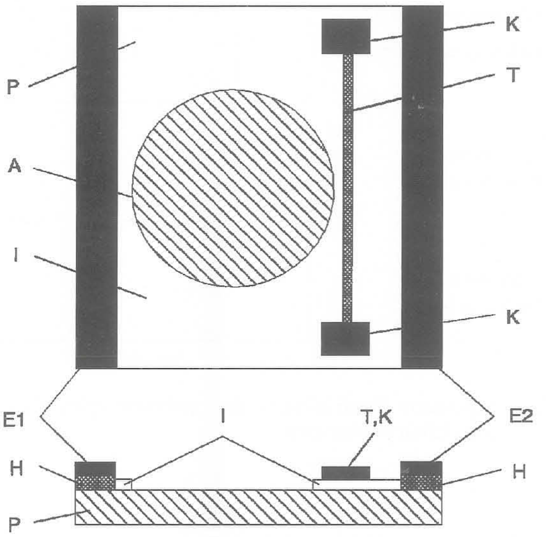

Fig. 5 Design of the silicon etalon in thin-film technology. Characteristics of the silicon nitride layer I: thickness 400 nm, thermal conductivity λ = 1.95 W/(mK), density ρ = 2 g/cm³, specific heat c = 500 Ws/(kgK); with a temperature difference of 20 K heat is transferred from the silicon plate P to the silicon nitride with 240 K/μs. Characteristics of the nickel resistor T: thickness 250 nm, λ = 52 W/(mK), ρ = 8.7 g/cm³, c = 448 Ws/(kgK); with a temperature gradient of 20 K, heat is transferred from the silicon nitride to the nickel with 4000 K/μs.

for making contact on the ends of the nickel resistor. Due to the extremely small layer thickness, the heat is transferred very rapidly from the silicon to the nickel strip resulting in a temperature measurement with a quick response (see caption of Fig. 5).

The optical radiation to be filtered enters area A (diameter 6 mm). The reflectance $r = 0.3$ is obtained for silicon by using the Fresnel equation [14]. Hence the pure silicon plate can be used immediately as an etalon, even if the narrowness is relatively limited. To enhance the reflection narrowness, surface A can be coated on both sides with dielectric mirrors. Electrical contacts with the etalon are carried out by bonding.

The base plays a decisive role in the etalon operation for mechanical fastening and for electrical contacts (bonding). However, the base's function as a defined heat dissipation is much more important; operation without it would result in an unacceptably long cooling time. The material to be used should demonstrate long-term stability up to 250 °C and be electrically insulated, while exhibiting sufficient heat dissipation. Few materials are capable of demonstrating these characteristics; two examples of materials suitable for this task are: glass-reinforced PTFE or ceramics. Figure 6 illustrates the entire structure of the etalon with a PTFE base. An electronic PI controller (not shown in the diagram) is used for precise adjustment of the required etalon temperature.

Figure 7 illustrates the structure of the entire correlation photometer. The radiation from the radiation source is modulated by the chopper and enters collimator lens 1. Behind the lens is a sample cell containing the gaseous mixture to be analyzed, followed by the thermally-tuneable etalon. The distance between the radiation source and lens 1 is adjusted such that the image of the incandescent coil is formed at the site of the etalon. The radiation is limited to the required spectral region by means of the interference filter. The following collimator lens 2 focuses the radiation onto the photodetector.

The incandescent coil features the dimensions 2.5 mm × 5 mm. The electrical power is approximately 3 W and corresponds to a color temperature of approximately 700 K. Based on Wien's law, maximum radiation occurs at a wavelength of approximately 4.1 μm. The lenses are made from calcium fluoride, exhibiting sufficient transmission in the infrared region examined. A thermoelectrically cooled PbSe detector, operating at - 20 °C is used for measuring the radiation flux. The detector signal is rectified with a lock-in amplifier in a phase-sensitive manner. Further signal processing is done by a computer.

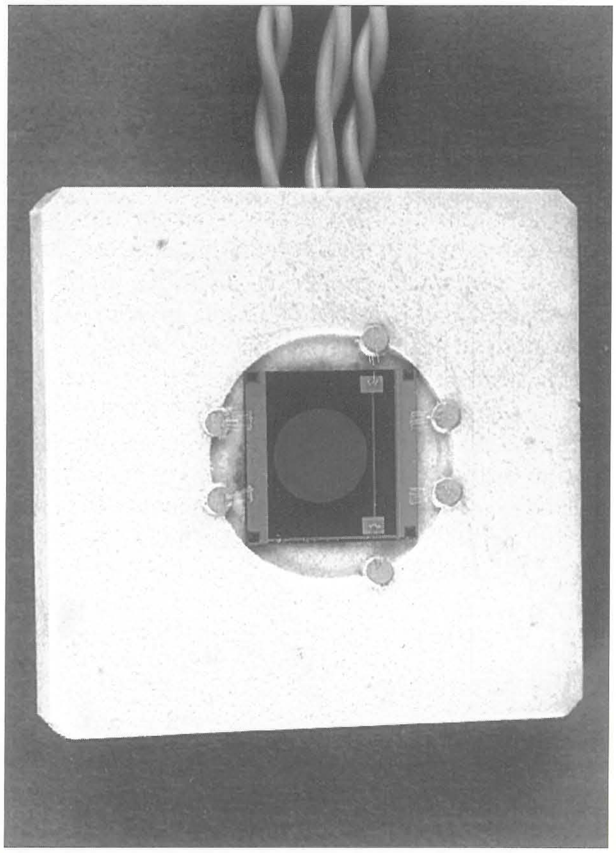

Fig. 6 Photographic image of the silicon etalon with base. A temperature-resistant adhesive with adequate thermal conductivity is used for fixing the etalon.

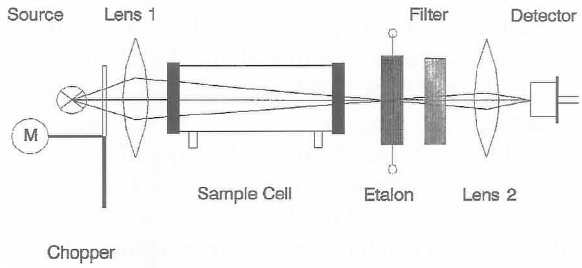

Fig. 7 Schematic design of the correlation spectrometer. Length of the sample cell 27 cm, collimation distance of lens 1: $f = 50$ mm; collimation distance of lens 2: $f = 40$ mm; distance between etalon and lens 1: 33 cm, chopper frequency: 175 Hz.

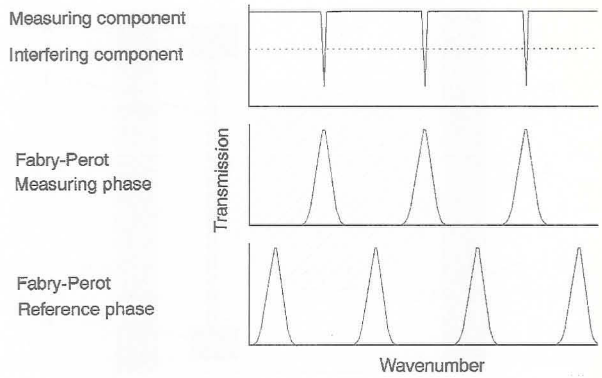

Fig. 8 Schematic illustration of the operation principle of the correlation photometer.

Only two discrete values, rather than the entire correlation function, are used for measuring the concentration of the gas component required. The etalon temperature is tuned during the measurement phase such that the interference lines coincide exactly with the absorption lines of the measuring component (resonance position), and the interference pattern is shifted by a half interference order during the reference phase (antiresonance position). Both phases are shown opposite each other in Fig. 8. In the case of the CO measurement, the temperature difference between the measurement and reference phases is only approximately 16 °C. The overlapping spectra of the sample gas and of the Fabry-Perot are integrated across the wavenumber by the wideband detector.

Two properties are of paramount importance: although the measurement and reference radiations differ with respect to their spectral line structure, their spectral center of gravity is identical. Both the measurement and reference radiations pass through the same optical beam path. If the quotient I_M / I_V is calculated from the time-multiplex detector signals I_M and I_V, corresponding to the measurement phase or reference phase, a signal independent of the non-specific fluctuations of the radiant power and detector sensitivity is obtained. In this manner, the pre-conditions for high stability of zero point and sensitivity are fulfilled.

5 Measurements

The time response of the silicon etalon is important when using the thermally-tuneable silicon etalon method. Figure 9 illustrates the warm-up and cool-down behavior when the etalon oscillates permanently between two temperatures. The difference between both setpoint temperatures of the controller corresponds to approximately the distance between the resonance and antiresonance position when measuring CO.

The functional course during the warm-up phase, assuming practically a rectangular shape, clearly shows that the control system is sufficiently rapid. The cool-down rate is however about 4.5 times less than the warm-up rate and can only be increased by employing a base material with a higher thermal conductivity. The first exemplary measuring component is CO whose correlation function (see section 2) is measured as a function of the etalon temperature. The results are given in Fig. 10. The lower diagram shows the correlation function of the structured absorbing component N_2O. Due to the smaller distance between the N_2O lines, about four times the oscillation frequency of the correlation function is obtained. The N_2O correlation contrast is less by approximately one order of magnitude than that of CO, even though the

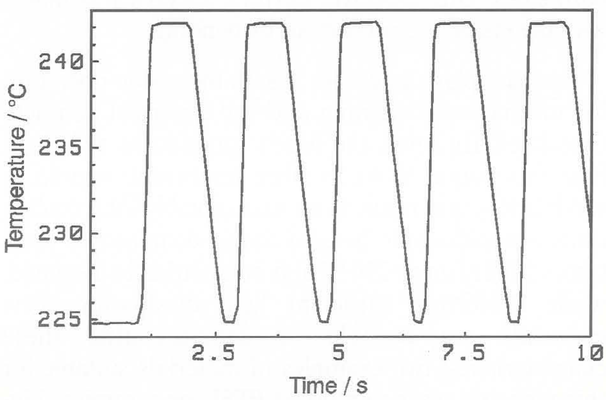

Fig. 9 Time response of the silicon etalon with PTFE base. Setpoint temperatures of the electronic controller approximately 224 °C and 242 °C, electrical power approximately 20 W, warm-up rate approximately 100 K/s, cool-down rate 23 K/s.

absolute correlation degree is practically one order of magnitude above that of CO. Converted to the same concentration as that of the measuring and interfering component, a contrast ratio of 50 is obtained. Therefore, the suppression degree for the interfering component is also 50.

The two vertical lines indicate two temperature values for the resonance and antiresonance position (measurement and reference phases). With respect to the interfering component, these temperature values represent the most unfavorable case: the N_2O contrast fully appears. Selectivity can, however, be optimized by using the "phase alignment". By increasing the reference temperature by approximately 3 °C, the N_2O influence can be fully compensated, with the CO measurement effect being only slightly reduced. To make matters simple, a 10 mm-thick sapphire window is used as a wideband absorbing interfering component and is placed in the optical beam path in the vicinity of the etalon. The absolute transmission is approximately 0.4 in the wavenumber range around 2150 cm^{-1}.

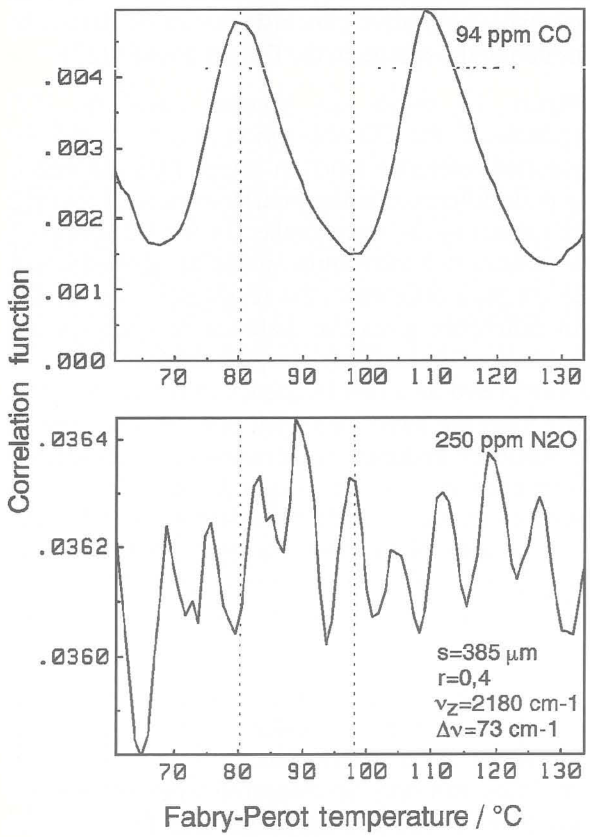

Fig. 10 Measured correlation function as a function of the Fabry-Perot temperature for the measuring component CO (above), and the interfering component N_2O (below). Etalon thickness s = 385 μm, the resultant free spectral range corresponds to approximately the distance between the CO lines m = + 1 and m = + 2.

The measurement yields the correlation degree 0.38 whereas no correlation contrast can be noticed within the measuring accuracy, and therefore no graphic representation is given. The second example is the measuring component NO with the interfering component water vapor, whose absorption spectrum completely overlaps the NO spectrum. The measured correlation functions of NO and water vapor are illustrated in Fig. 11. The conditions obtained here are less favorable than those in the first example; the correlation contrast of both functions is of approximately the same magnitude and the oscillation frequencies are identical. Again, one must determine the most favorable combination of measurement and reference temperatures at which the water vapor influence virtually disappears. The broken lines in the diagram indicate a suitable solution where the maximum NO contrast is reduced by only about 20 %.

The measurement results obtained from the two measuring systems chosen demonstrate the high selectivity of the correlation photometer. In all cases, it is possible to effectively suppress both the wideband and the structured absorbing interfering components. By using the optimal temperature values for the measurement and reference phases, it is possible to measure the correlation degree as a function of time: for this purpose, the etalon temperature is regulated such that it permanently oscillates between both values. The radiation flux measured in each case is sampled and the time-dependent function $c(t) = 1 - I_M / I_V$ is calculated, showing the gas concentration in the linear approximation (I_M detector signal in the measurement phase, I_V detector signal in the reference phase).

Figure 12 illustrates the time-dependent concentration measurement, using the measuring component CO as an example. The inert gas nitrogen

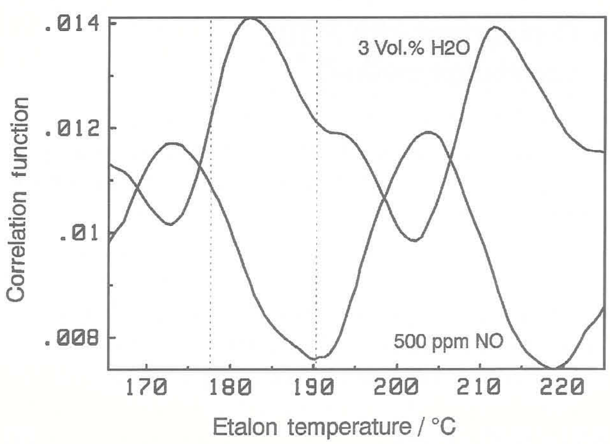

Fig. 11 Correlation function as a function of the etalon temperature for the measuring component NO and the interfering component H_2O. Etalon thickness s = 432 μm, effective reflectance r_e = 0.29, filter center v_z = 1897 cm^{-1}, filter bandwidth Δv = 50 cm^{-1}.

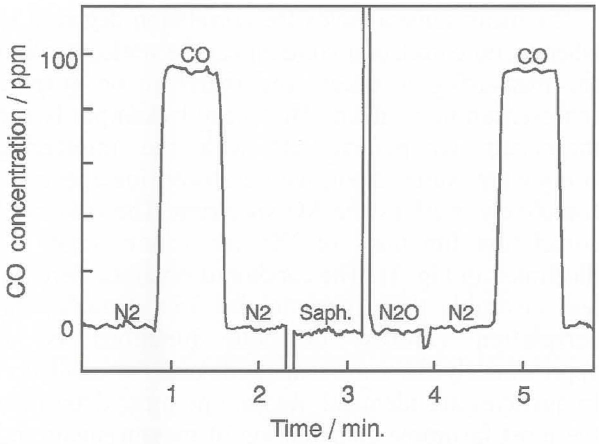

Fig. 12 CO concentration as a function of the time. Etalon temperature in the measurement phase 182 °C, in the reference phase 165 °C. Time constant of the lock-in amplifier 5 s. Etalon thickness 385 μm, effective reflectance 0.4, central wavenumber of the filter 2170 cm^{-1}, filter bandwidth 39 cm^{-1}, gas concentrations: 94 ppm CO, 250 ppm N_2O; sample cell length 270 mm.

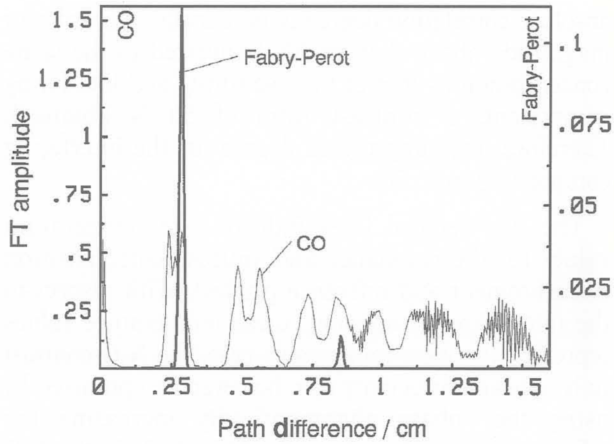

Fig. 13 Fourier transform amplitude of the CO absorption spectrum and filtered reference function as a function of the path difference. Fabry-Perot: reflectance r = 0.3; filter function F(v); v_z = 2174.5 cm^{-1}, Δv = 50 cm^{-1}, Gaussian-shaped.

(N_2) is used for zero-point adjustment. The selectivity of the system has been tested using the sapphire window described earlier (wideband absorption) as well as the interfering gas N_2O (structured absorption). The measurement curve clearly indicates that both interfering components can be suppressed. The two major signal deflections in the center of the diagram are caused by the inward and outward movements of the sapphire. The radiation flux is briefly interrupted here and the input signal adapts to the new values according to the lock-in time constant. A detection limit of approximately 2 ppm CO can be derived from the diagram. If necessary, this value can be further enhanced by increasing the correlation contrast (e.g. a longer sample cell).

6 Comparison with NDIR correlation method

The relevant features of the Fabry-Perot correlation method are compared with those of the NDIR correlation method (with two-layer detector). The latter method is a long established procedure [26, 28] representing an industrial standard. The selectivity of the methods can be conveniently compared by using their reference function. The reference function of the Fabry-Perot correlation method is expressed as

$$R(v) = P_V(v) - P_M(v), \quad (4)$$

where P_V and P_M denote the Airy function in the reference phase or measurement phase (see section 2). The function therefore represents the reference spectrum which has been modulated with respect to the wavenumber, and interferometrically saved in the measuring instrument since it is used for simulating the absorption spectrum of the measuring component. Important qualitative conclusions can be drawn by considering the spectra in the Fourier domain [27].

Figure 13 shows the Fourier transform (FT) amplitude of the CO absorption spectrum and the associated reference function versus path difference. The path difference is the Fourier-associated variable with respect to the wavenumber. In the CO spectrum, one notices two maximum values at approximately 0.26 cm path difference; the reciprocal value of this path difference gives the distance between the CO rotation lines. Accordingly, the path difference can also be interpreted as a line frequency (not wavenumber). Apart from the basic frequency, one can also observe the frequency multiples as "harmonics", which are well pronounced due to the sharp Lorentz lines. The resonance frequency of the Fabry-Perot interferometer coincides with the CO basic frequency. Apart from the Fabry-Perot resonance frequency, uneven frequency multiples can be observed (with a very slight amplitude).

In principle, this measuring process is sensitive only for the path difference for which the Fourier transform amplitude is a value other than zero. Therefore, a gas component can only be measured when the Fourier transforms of the gas spectrum and the reference function overlap. However, maximum sensitivity occurs only when both spectra are "in phase". With regard to the suppression of an interfering component, no Fourier transform should overlap. If they do overlap, the interfering component can generally be suppressed by phase alignment. The following statement is valid for the illustrated Fabry-Perot reference function: since the FT amplitude is zero for a path difference of zero, wideband absorbing interfering components are ideally suppressed, as confirmed by the measurements in section 5. Favorable preconditions are also given for the suppression of structured absorbing interfering components. Due to the very small portion of frequency multiples, there is only a slight probability of overlapping.

The reference function of the two-layer NDIR method is expressed as

$$R^{\mathrm{NDIR}}(v) = 1 - 2\exp\left[-a_1(v) \cdot c_R \cdot l_{R1}\right] + \exp\left[-a_1(v) \cdot c_R \cdot (l_{R1} + l_{R2})\right] \quad (5)$$

where l_{R1} is the length of the front detector chamber, l_{R2} is that of the rear chamber, c_R is the filling gas concentration and $a_1(v)$ is the absorption spectrum of the filling gas [14]. The FT amplitude of a typical CO reference function is shown in Fig. 14.

Unlike the Fabry-Perot method, pronounced harmonic contents are manifested by the NDIR method, resulting in a considerably greater probability of overlapping by an interfering component. As shown above, the amplitude is zero for a path difference of zero, but the first maximum appears for a small path difference (see Fig. 14). Overall, one can state that unstructured interfering components can be well compensated, but less selectivity must be expected in the case of structured absorbing components. Selectivity can be enhanced within certain limits by altering the chamber geometry; nevertheless, the NDIR method shows a fundamental drawback: unlike the Fabry-Perot method, the phase position of the reference spectrum cannot be arbitrarily modified; the phase position is fixed by the gas filling of the detector chamber.

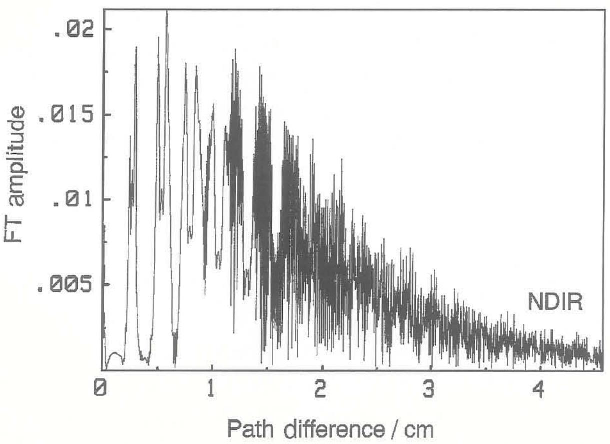

Fig. 14 FT amplitude of the filtered CO reference function of the NDIR method as a function of the path difference. l_{R1} = 0.74 cm, l_{R2} = 2.1 cm, c = 0.17 bar; filter function: v_z = 2135 cm^{-1}, Δv = 150 cm^{-1}.

The NDIR method performs better when sensitivity is concerned, being twice that of the Fabry-Perot method. This can be attributed to the exact coincidence between the line positions in the reference and measuring component spectra. This is not the case in the Fabry-Perot method, since the interference lines are equidistant but the gas lines are not usually arranged equidistantly. If one compares zero stability, the Fabry-Perot method has the advantage that the measurement and reference radiations traverse the same optical beam path so that, for example, contamination of the sample cell can be easily compensated. In the case of the NDIR method, one measurement cell and one reference cell are always needed and these may exhibit different contaminations.

7 Conclusions

Measurements performed with the laboratory prototype demonstrate that a high-performance Fabry-Perot correlation photometer can be designed. This is mainly attributed to the newly designed, tuneable silicon etalon. By virtue of its small dimensions, a compact photometer can be obtained and further advantages arise from the fact that the etalon features no movable parts and can be easily and economically manufactured using thin-film technology.

Due to the high zero stability, the method is particularly destined for in-situ measurements, whose calibration problems are well-known. The Fabry-Perot correlation photometer is characterized by very high selectivity due to the flexibility of the interference lines and therefore promises interesting application possibilities in industrial gas analysis where, due to inadequate zero stability or selectivity, other methods run the risk of producing incorrect measurement data. ■

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FLOW MEASUREMENT

KRISS high-pressure gas flow standard system

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1 Introduction

Natural gas consumption in Korea has rapidly increased since the late 1980's due to the development of industry and an improved standard of living. Korea Gas Corporation (KGC) imports close to five million tons of liquefied natural gas annually. Research on the high-pressure gas flow measurement technology is of paramount importance for efficient and effective operation and better accuracy. Under these circumstances, KRISS began building a high-pressure gas flow primary standard system in the late 1980's under the sponsorship of KGC.

For the design of the standard system, four different types of facilities, i.e., a phase change loop type, a blow-down type, a flow-through type and recirculating flow loop type, were thoroughly investigated at several research institutes throughout the world. A blow-down type was chosen due to the possibility of designing a large capacity standard system with an optimal combination of a compressor and a storage tank at low initial installation and maintenance costs. The disadvantages of this type are the following: it takes longer to fill the storage tank when the capacity of the compressor is rather low; there are also some difficulties when controlling the discharge of high-pressure gas for generating high quality steady state conditions for a desired period of time.

2 Primary high-pressure gas flow standard system

The standard system at KRISS can generate steady state air flows within the pressure range of 0.1 to 5 MPa. A gravimetric method using a fast actuating diverting valve system and a gyroscopic weighing system was employed for the primary standard of mass flow rate. The maximum steady state flow rate, which should be maintained long enough to do a primary calibration, was 10 000 m^3/h at the standard state (101.325 kPa and 293.15 K). The schematic diagram of this standard system is shown in Fig. 1.

Two compressors with a free air delivery of 0.33 m^3/s and outlet pressure of 7.1 MPa are used to fill a 20 m^3 storage tank at up to 6.5 MPa. The storage tank is made of two pieces of pipes, both with a length of 30 m and a diameter of 0.66 m. Compressed air passes through a purification filtering system to provide rather clean air with an oil content not greater than 5 ppm and a dew-point temperature lower than - 40 °C. All dust and particles with sizes greater than 5 μm are removed using a particle filter.

In order to obtain stable temperature and pressure conditions during a test run, air pressure from the storage tank is regulated at about 5 MPa and then stored again in the temperature control loop until the air temperature stabilizes. The entire length of the loop is about 45 m and its volume is 7 m^3. For calibration of the flowmeter, air from the temperature control loop is regulated again to a working pressure and discharged into the test line.

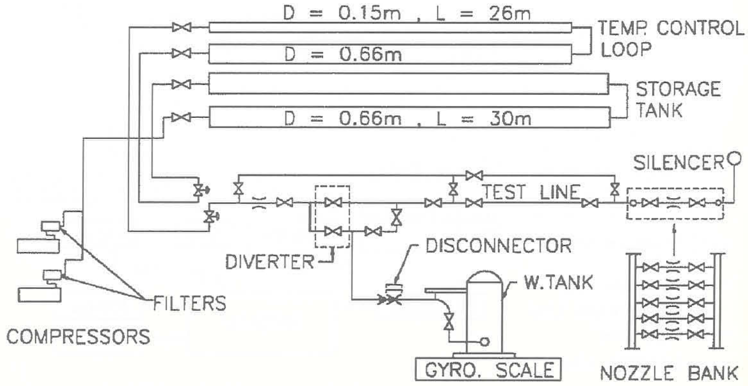

Fig. 1 Schematic diagram of the high-pressure gas flow standard system.

Air passed through a sonic nozzle may be directed either to the open air via a silencer or to the weighing tank placed on a gyroscopic weighing system. A nozzle installation package is designed according to an ISO standard [2]. Two ball valves of the diverting system are installed as shown in Fig. 2 and operated by a pinion and rack with a hydraulic system.

The weighing tank can be disconnected from the pipeline by a specially-designed coupling before and after the collection of air. The weighing tank has a volume of 2 m^3, has a cylindrical shape and withstands pressure up to 5 MPa and temperature ranges from -10 °C to 40 °C. The weighing tank is balanced on a gyroscopic weighing system which was custom-built for KRISS by Wöhwa Waagenbau of Germany.

For accurate measurement of the mass of air passed through the sonic nozzle, compensation has to be made for unweighed air contained in the pipeline between the nozzle and the block valve at the weighing tank inlet. The volume of the unweighed air, which amounts to 0.8 % of the volume of the weighing tank, has been determined by volume measurement with an accuracy of ± 1 % . The pressure and temperature of air contained in the pipeline are measured and recorded at the beginning and end of each diversion to determine the mass of unweighed air.

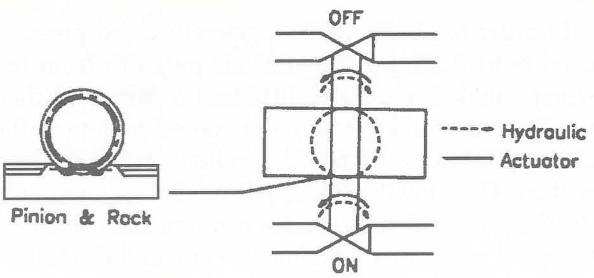

Fig. 2 Schematic diagram of diverting system.

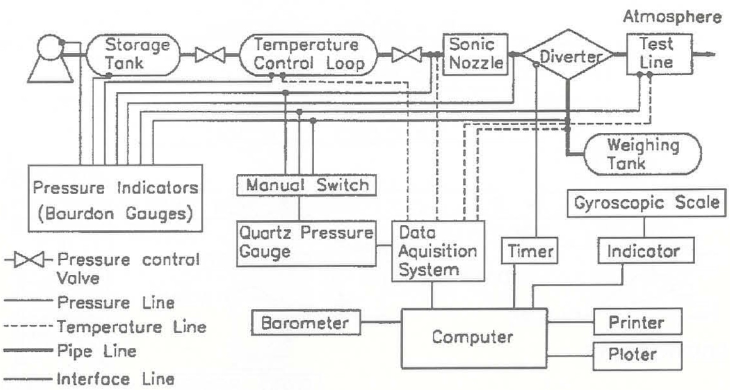

Fig. 3 Layout of data acquisition hardware and pressure monitoring console.

The testline, which consists of a pipe of 9 m × 0.1 m, is used to pass air from the sonic nozzle to a test meter. By installation of a nozzle bank at the end of the test line, the flow rate can be changed with any combination of five nozzles from 10 to 1 240 m^3/h. The test meter can either be calibrated against the sonic nozzle upstream of the test meter or against the nozzle bank downstream of the test meter.

The hardware and software of the data acquisition system exclusively developed for the high-pressure flow standard system provide a comprehensive and rapid means for collecting flow-related data over the entire range of operating conditions. The hardware consists of measuring instruments interfaced to a computer as shown in Fig. 3.

Pressures upstream of the sonic nozzle and the testline are measured using two Ruska fused quartz pressure gauges (RUSKA 6000). Output of the fused quartz gauge is sent to the data acquisition system (HP 3852) interfaced to a microcomputer (HP 310). Pressure at the pipeline between the diverter and the block valve is measured using a Heise precision pressure gauge (CMM 45388). The pressure monitoring console consists of six Bourdon gauges for monitoring pressure at the compressor outlets of the storage tank, the temperature control loop, and the testline. Atmospheric pressure is measured using a digital barometer (CEC 2500). Two high precision PT-100 sensors are used to measure temperatures upstream of the sonic nozzle and in the pipeline connected to the weighing tank. Another three PT-100 sensors are installed at the storage tank, the temperature control loop and the testline. Those PT-100 sensors are interfaced with the data acquisition system.

The collection time of air into the weighing tank is measured with a counter (HP 5316B) triggered by a photo-interrupter in the diverting system. All instruments (including the gyroscopic weighing system indicator) are interfaced with the computer. The software for data acquisition and processing was developed to interface instruments and to perform necessary computations by utilizing experimental data. For the determination of the pressure and temperature upstream of the sonic nozzle, pressures and temperatures are measured ten times while air is collected in the weighing tank, and the average value of ten measured data is used for computing the discharge coefficient.

3 Evaluation test of the standard system

In the gravimetric flow standard system, the standard mass flow rate is determined by weighing the mass of air collected over a well-defined period of time. The errors associated with mass and time measurements influence the final accuracy of the standard mass flow rate, and furthermore, the pressure and temperature stability of the air flow may be considered as an additional factor. Prior to the primary calibration of critical sonic nozzles against the gravimetric standard system, the gyroscopic weighing system should be calibrated to determine the mass measurement error using deadweights traceable to the national standard. Subsequently, the pressure and temperature variations of the flow were observed as a function of time at different flow rates. The error arising from the collection time measurement was investigated by testing the flow diverting system.

3.1 Mass measurement error

After installation of the gyroscopic weighing system, the sensitivity of the weighing system was found to be 2 g over the entire weighing range from 0 to 80 kg with a tare weight of 2.2 tons. However, it was found that air movement in the laboratory can result in a small movement of the weighing tank, therefore making the indication of the weighing system unstable. By reducing the sensitivity to 5 g, stability of this indication was improved. Calibration of the gyroscopic weighing system was performed using deadweights traceable to the national standard. Deadweight was increased from zero to 80 kg with 10 kg intervals and then decreased by 10 kg to zero. The same procedure was repeated three times and the data scattering did not exceed ± 5 g. The results of the calibration are shown in Fig. 4.

3.2 Pressure and temperature stability

The variations of pressure and temperature upstream of the sonic nozzle were monitored over the pressure range from 1 to 5 MPa as a function of time. Since the air collection time required for each calibration is different, behavior of the pressure and temperature fluctuations from approaching gas to the nozzle during calibration has to be investigated in order to assess the magnitude of errors arising from the data processing method.

For determining the pressure and temperature upstream of the sonic nozzle, these are measured ten times while air is collected in the weighing tank, and the average value of ten measured data is used for computing the discharge coefficient. The test results at the flow rate of 4 000 m^3/h at a standard condition are shown in Fig. 5. The pressure fluctuation was found to be less than ± 1 kPa at 5 MPa and the temperature fluctuation was less than ± 0.02 K at 290 K during an observation period of one minute.

3.3 Time measurement error

The collection time of the compressed air into the weighing tank is measured by a counter triggered by a movement of the pinion and rack system which opens and closes ball valves. Pressure of the hydraulic system of the diverting system was adjusted in order to open and close valves within 50 ms and the counter triggering position was adjusted as suggested in ISO 4185 [3] for further reduction of the collection time measurement error (see Fig. 6). When the air collection time is longer than 60 s, the time measurement error associated with flow diversion may be considered to be less than ± 0.08 %. The counter itself appears to have a negligible error since its resolution is smaller than 0.01 ms. This is estimated by taking into account the

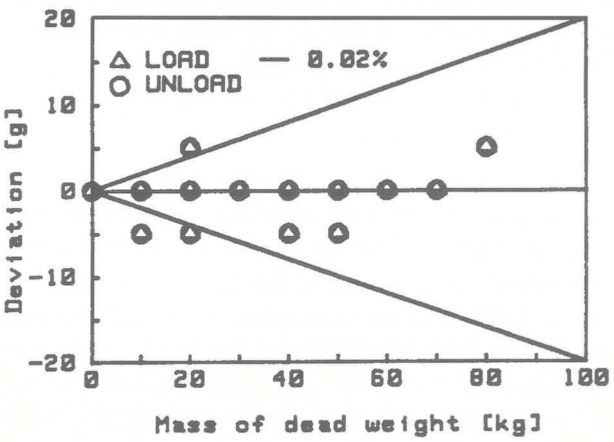

Fig. 4 Calibration of the gyroscopic weighing system with deadweights.

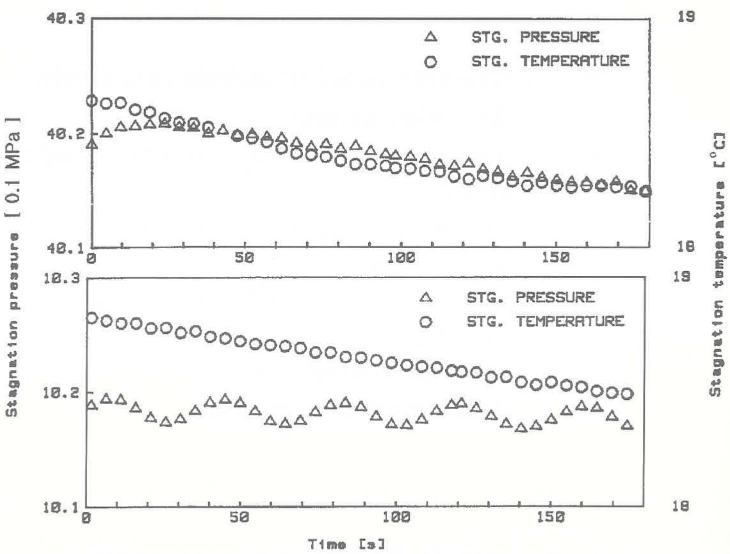

Fig. 5 Fluctuations of stagnation pressure and temperature.

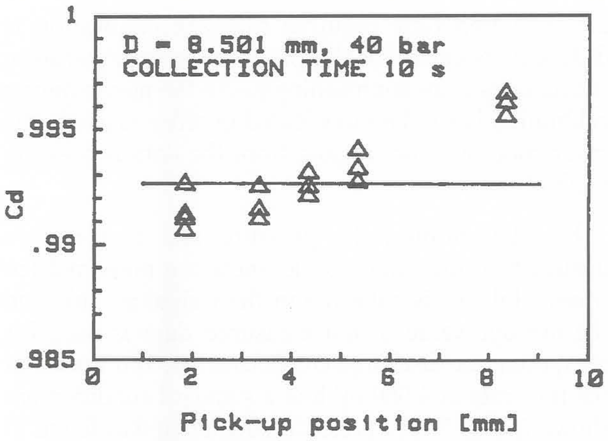

Fig. 6 Discharge coefficient of sonic nozzle with variation of counter triggering position.

stability of the quartz oscillator and the discrimination of the indicator unit. In the higher flow rate, however, the air collection time has to be decreased to less than 60 s due to the capacity of the weighing tank, and therefore, the error of the diversion time should be reduced further in order to maintain the desired accuracy level. According to ISO 4185, this may be accomplished by adjusting the triggering point of the counter.

4 Uncertainty analysis*

The mass flow rate at steady state in a gravimetric system is given as follows:

$$q_m = \frac{m}{t} = \frac{1}{t}\,[m' + V_d(\rho_{atm,2} - \rho_{atm,1}) + V_L\,(\rho_2 - \rho_1)] \qquad (1)$$

where:

- m : mass of air passed through the sonic nozzle;
- t : flow collection time;
- m' : mass indicated by the gyroscopic weighing system;
- V_d : volume of air displayed by the weighing tank;
- V_L : volume of the pipeline between the nozzle throat and the stop valve at the inlet of the weighing tank;
- ρ_{atm} : atmospheric density; and
- ρ : density of air in the pipeline.

(*) *Note from BIML: This analysis does not conform with the "Guide to the Expression of Uncertainty in Measurement", 1993 edition.*

In equation (1), the changes in volume of the weighing tank and the pipeline due to the pressure and temperature variations were neglected. The uncertainty of the system can be calculated by the following equation:

$$\frac{\delta q_m}{q_m} = \pm \left[\left(\frac{\delta t}{t}\right)^2 + \left(\frac{\delta m}{m}\right)^2\right]^{1/2} \qquad (2)$$

where:

$$\frac{\delta m}{m} = \frac{\delta m' + \delta\,[V_d(\rho_{atm,2} - \rho_{atm,1})] + \delta\,[V_L(\rho_2 - \rho_1)]}{m' + V_d(\rho_{atm,2} - \rho_{atm,1})] + V_L(\rho_2 - \rho_1)]}$$

As discussed earlier in the section 3 *Evaluation test of the standard system,* the weighing error of the gyroscopic weighing system ($\delta m'$) does not exceed 5 g. Temperature of the outer wall of the weighing tank is increased while the tank is filled with air. Therefore, it may be considered that there is a very thin thermal boundary layer outside the tank. If the control volume includes the thin thermal boundary layer, the buoyancy force, $V_d(\rho_{atm,\,2} - \rho_{atm,\,1})$, can be expected to increase as much as the volume of the thermal boundary layer. An experimental increase of the buoyancy force was found to be negligible because the weight only decreased by 5 g during an approximate wait of 30 minutes for thermal equilibrium.

Furthermore, this force works in the opposite direction of buoyancy effect. In fact, the zero point of the gyroscopic weighing system always remains constant during the calibration. Since the pipeline volume between the nozzle throat and the stop valve at the inlet of the weighing tank is only about 0.8 % of the weighing tank volume, 1 % of measurement error for the pipeline volume at 4 MPa results in a compensation error of ± 0.16 g. Therefore, the mass determination error of the air passed through the sonic nozzle is governed by the sensitivity setting value of the gyroscopic weighing system.

At the selected counter triggering point (x = 4.5), the discharge coefficient variation of the "8.501 mm nozzle" was observed as a function of collection time. For this experiment the pressure of the flow was adjusted to about 4 MPa and the temperature was fixed at about 20 °C. The Reynolds number at the nozzle throat was estimated as 5.2×10^6. The counter used for the measurement of collection time has an uncertainty of less than ± 0.001 % when the duration of the collection time is maintained longer than 10 s. In Fig. 7, scattering of the data is less than ± 0.02 % when the collection time is longer than 30 s. However, it increases to ± 0.05 % when the collection time is 10 s.

Considering the capacity of the nozzle used for the experiment, it is impossible to collect more than 6 kg of air for 10 s and this results in a significant weighing uncertainty which appears to have caused large scattering. The weighing uncertainty is less than ± 0.03 % when the collection time exceeds 30 s with this nozzle. In fact, by extending collection time to 120 s, about 67 kg of air was collected and the scattering of the discharge coefficient data decreased to less than ± 0.01 %. The systematic deviation due to collection time tends to increase as the collection time becomes shorter; it is about 0.05 % when the collection time is 30 s, but less than 0.02 % when collection time is more than 60 s.

When a critical sonic nozzle is calibrated against the system, the equation for discharge coefficient is given as follows:

$$C_d = \frac{(m/t)}{A^* C^* P_0 / \sqrt{R T_0 / M}} \qquad (3)$$

where:

- m : mass of the air passed through the nozzle throat;
- A^* : cross sectional area of the nozzle throat;
- C^* : critical flow function;
- P_0 and T_0 : stagnation pressure and temperature upstream of the nozzle;
- R : universal gas constant; and
- M : molecular weight of air.

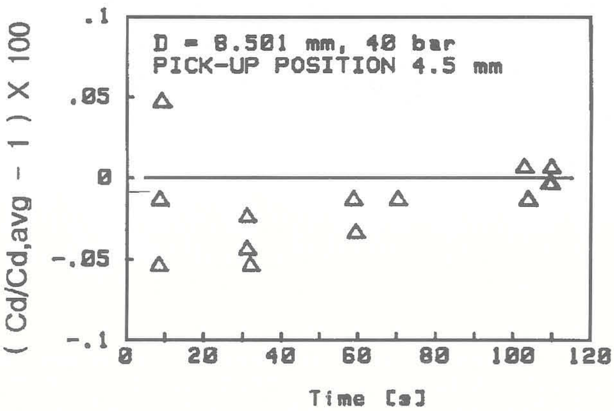

Fig. 7 Discharge coefficient of sonic nozzle with variation of collection time at x = 4.5 mm.

The overall uncertainty associated with the determination of the discharge coefficient of a critical sonic nozzle is given as follows:

$$\frac{\delta C_d}{C_d} = \pm\left[\left(\frac{\delta(m/t)}{(m/t)}\right)^2 + \left(\frac{\delta A^*}{A^*}\right)^2 + \left(\frac{\delta C^*}{C^*}\right)^2 + \left(\frac{\delta P_0}{P_0}\right)^2 + 1/4\left(\frac{\delta T_0}{T_0}\right)^2 + 1/4\left(\frac{\delta M}{M}\right)^2\right]^{1/2} \qquad (4)$$

In equation (3), when air is used as a test fluid, the critical flow function C^* is determined from published data [1] and considered as not having an uncertainty. The molecular weight error of the air depends on the composition change but its change is negligible. The measurement error of the nozzle throat is about 1 µm. Since the smallest nozzle used during this study is 4.225 mm, $\delta A^*/A^*$ is less than 0.047 %. Uncertainty factors and their estimated magnitudes are summarized in Table 1.

Overall random and systematic errors associated with primary calibration of sonic nozzles may be estimated from Table 1. In the calibration data, only the random error appears to be repeatable. It should be less than ± 0.02 % when more than 25 kg of air is collected for weighing. Systematic error varies depending on the nozzle size and the working pressure. The effect of pressure drift becomes significant when upstream pressure of the nozzle is low. Calibration data of the nozzle having a throat diameter of 8.501 mm are shown in Fig. 8 as a function of the Reynolds number. When about 32 kg of air is collected for 60 s at a stagnation pressure of 4 MPa, scattering of data is less than ± 0.02 %. It increases as the Reynolds number decreases by lowering the pressure. At 1 MPa, the mass

Table 1 Nozzle calibration error sources and magnitude.

	Systematic error		Random error	
Source	Magnitude	Comment	Magnitude	Comment
Mass	± 0.008 %		± 0.02 % > ± 0.1 %	> 25 kg < 5 kg
Time	± 0.05 % < ± 0.02 %	t = 30 s t > 20 s	< ± 0.001 %	t > 10 s
Pressure	± 0.1 % ± 0.025 %	at 1 MPa at 4 MPa	± 0.025 %	
Temperature	± 0.035 %	at 20 °C	± 0.007 %	
A*	± 0.047 % < ± 0.02 %	φ = 4.2 mm φ > 8.5 mm		

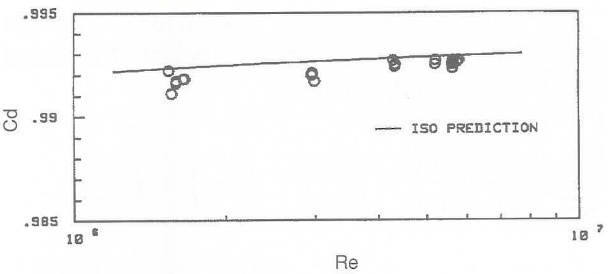

Fig. 8 Calibration data for a 8.501 mm nozzle.

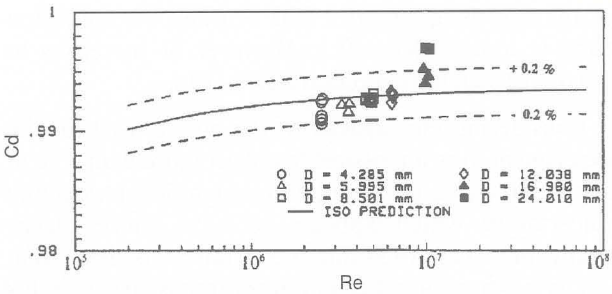

Fig. 9 Discharge coefficient of sonic nozzles.

of air collected in the weighing tank during a period of 60 s is about 8 kg and the weighing uncertainty is expected to be as high as ± 0.063 %.

Calibration results of six nozzles obtained at 4 MPa or at the highest possible pressure in the case of nozzles with large throat diameters are summarized in Fig. 9. Since the effect of systematic error sources does not appear until they are compared with data obtained by different systems of different laboratories, discharge coefficient values calculated according to ISO 9300 [2] are used as a reference. The 24.010 mm nozzle shows a relatively large deviation because this nozzle cannot have a long enough collection time to minimize the diversion error.

In fact, about 50 kg of air was collected in the weighing tank for 12 s at 3 MPa. Due to a relatively short collection time, at least 0.05 % of the systematic diversion error was expected. Meanwhile, the 4.285 mm nozzle needs a collection time of more than 360 s in order to collect about 50 kg of air. Larger scattering of calibration data than expected might have been caused by an excessively long diversion time. Systematic effect caused by the measurement error of the nozzle throat diameter is also significant for a nozzle of this size.

5 Conclusions

- A high-pressure gas flow standard system of 10 000 m^3/h was developed for the primary standard calibration and its overall uncertainty was estimated as ± 0.05 %.
- The magnitude of random error is governed by the sensitivity setting of the weighing scale. With the sensitivity of 5 g, more than 25 kg of air has to be weighed to be within a ± 0.02 % uncertainty limit.
- Uncertainty in air collection time measurement as well as pressure and temperature stability of the system have a systematic effect on the primary calibration results.
- Discharge coefficients of sonic nozzles satisfactorily agreed with the values suggested in the relevant ISO documents [2, 3]. ■

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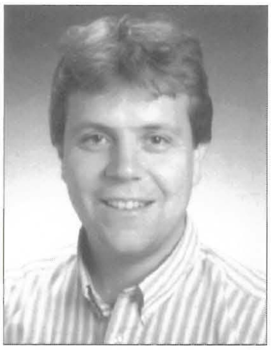

VERIFICATION ON SITE

Mobile mass comparator for verification and calibration of weights

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1 Introduction

This article describes a newly developed mobile 500 kg weighing system that will be used on site for calibrating and verifying M_1 and M_2 weights. The repeatability obtained with this system is better than 2.5 g. Our national measurement service verifies more than 900 class M_2 500 kg weights per year, these being distributed all over the country. Up to now, many of the nine verification offices in Norway have used a mobile mechanical 500 kg balance to verify their 500 kg weights. The drawbacks with this balance are that it takes a long time to mount on site, it is cumbersome in use and it is difficult to transport due to the size of its transportation case which is approximately 2 m^3.

2 Requirements

The general requirements for a new mobile weighing system are as follows:

Metrological requirements

- It must be possible to use the system to verify M_2 weights and to calibrate M_1 weights.
- The system should be capable of verifying 500 kg M_2 weights, which means that the standard deviation of 10 measurements must be less than or equal to 1/10 of the M_2 tolerance (7.5 g) [2].
- When calibrating M_1 weights the expanded uncertainty, U (calculated for a coverage factor k = 2), must be at least less than 1/3 of the M_1 tolerance (8.3 g) [5].

Practical requirements

- The system should be easily and quickly mountable on site, and capable of verifying weights of different designs. The different weights used by our service are shown in Fig. 1.
- For verifying M_2 weights, we aimed at using an industrial crane. This is an important requirement for avoiding the purchase and transport of a special crane for this purpose.
- It should be possible to transport the system in a common automobile, with the possibility of transporting the mechanical and loadcell systems in two or more parts.

3 Description of the mobile weighing instrument

3.1 Loadcell

The loadcell must have low creep and good repeatability. As a result of this requirement it was necessary to purchase a specially tested loadcell. The manufacturer sent us the best loadcell in a production series: an HBM Z3H3 with a sensitivity of 2 mV/V. We chose a tension cell because our repeatability requirement was not too strict and because it is easier to construct the necessary mechanics when such a loadcell is used. The tension cell is constructed as a strain gauge with a Z design. When loaded, this cell is stretched to about 0.22 mm vertically and about

Fig. 1 Illustration of the diversity of weights used in Norway.

0.001 mm horizontally. The connection box is mounted on the side of the loadcell. This may cause side forces and may be compensated for by loading the loadcell on the opposite side.

3.2 Mechanical system

Different mechanical components were used to ensure that the resulting force is correctly applied by the system. At the main connecting points, we used cones and conical pans which were manufactured to enable easy replacement after some years of use. At places of secondary importance, we used knuckles for connecting the different parts. Figure 2 illustrates the mechanical parts of the measuring system.

Since we aimed at using this system with a common industrial crane, a system is included in order to damp possible vibrations and oscillations. The system has a natural frequency between 10-20 Hz which is satisfactory. Between the cone/pan system and the triangle (see Fig. 2), a component ensures free rotation in a horizontal plane.

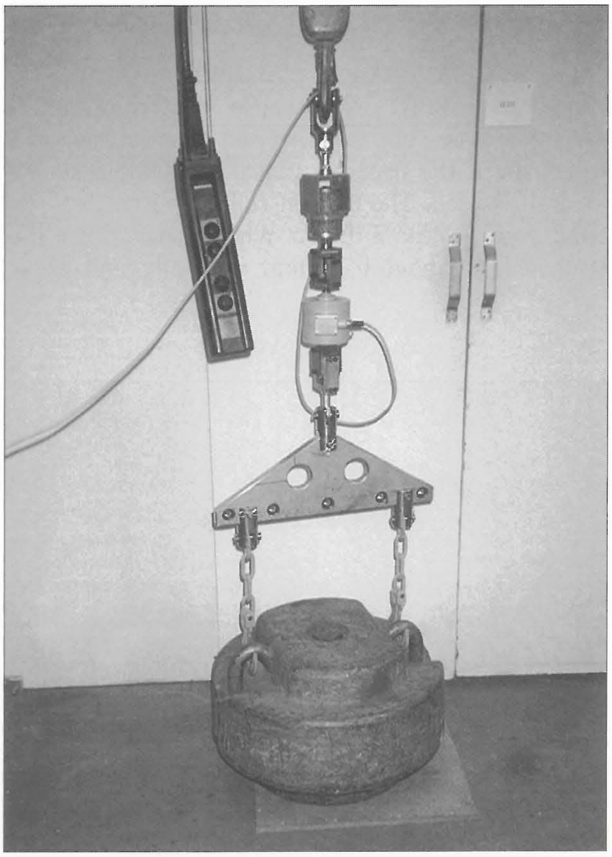

Fig. 2 The reference loadcell mounted with different mechanical components.

3.3 Personal computer and electronic parts

An EMC compatible box without display was chosen due to the fact that the system would be used in industry and connected to a personal computer. The resolution of the system is 10^{-6}.

3.4 Software

The software was developed using Lab-windows with the language C as the basic system. This software is suitable for programming and displaying graphs (Fig. 3). The measurement signal must be displayed continuously on the computer screen during the measurement procedure in order to check the following information:

- whether the instrument starts to measure too early (before it has reached stability)
- whether there are any vibrations that might influence the measurements
- stability of the indication. This has been found to be useful in checking the stability of the crane itself (stiffness of mechanical devices)
- whether all the signals have been transferred correctly.

The software is used to reduce the influence of creep since it performs the measurements at specified time intervals.

4 Tests of the weighing system

These tests are based primarily on OIML R 76.

Stability

The stability of the system is very good. At zero, the indication is within 1 g (during a period of 60 s) and at 500 kg, the indication is within 2 g. At 500 kg, the necessary time for reaching stability is about 40 s.

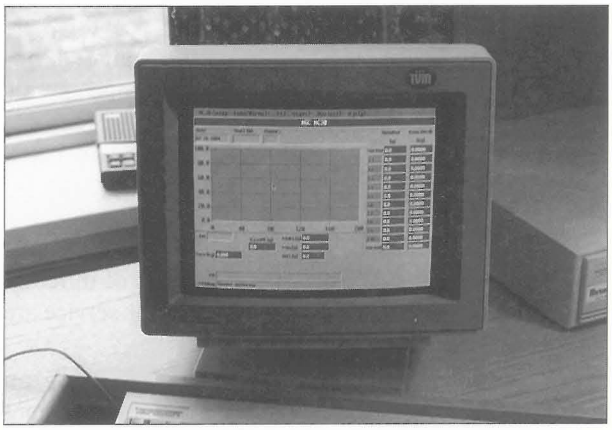

Fig. 3 A view of the PC screen during a measuring procedure.

Repeatability

Repeatability is taken as the standard deviation of 10 consecutive measurements at 500 kg. The standard deviation is 2.5 g, when using an industrial crane with a capacity of 1 t.

Sensitivity and linearity

These tests were performed at 500 kg. Figure 4 shows the results of overloading by 10 weights of 1 g. For overloading by 0,1–1 kg, the error is within ± 1 g. Above 1 kg, the error increased to about 12 g (at + 5 kg). Since all the weights should be within ± 75 g (equal to the M_2 tolerance), the sensitivity error may be considered as negligible.

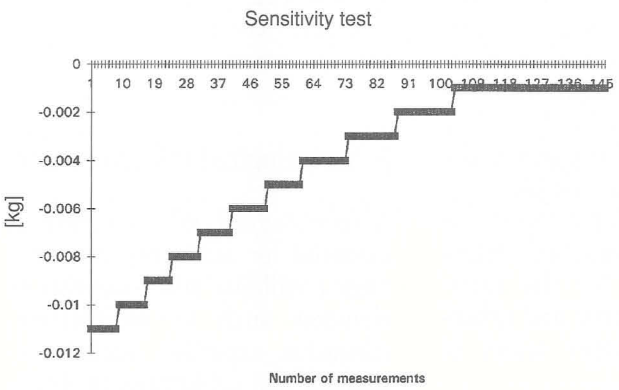

Fig. 4 Step by step overloading with weights of 1 g for testing the sensitivity of the weighing system.

Eccentricity

The eccentricity is tested by placing a 5 kg weight on top of the 500 kg weight, successively in each corner of the surface. This test results in an error of less than 1 g (due to the linearity error).

5 Conclusions

From the abovementioned results, it appears that all the requirements are satisfied, and due to the system's efficiency, verifying 80 weights of 500 kg per day is now possible. Another benefit of this system is that the same PC and electronics may be used when constructing a 50 kg weighing system. ■

References

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[5] OIML Recommendation R 111, *Weights of classes* E_1, E_2, F_1, F_2, M_1, M_2, M_3, March 1993.

[6] OIML R 76 *Nonautomatic weighing instruments Part 1 and Part 2.*

OIML LONG-TERM POLICY

Part 1 Metrology

1 Introduction

Measurement provides numerical descriptions of a wide variety of products and activities. Consequently, it serves as the basis for an extensive range of decisions concerning the everyday lives of human beings in fields such as trade, science and technology, industry, agriculture, health, and safety.

Examples of the impact of measurements on society

- A wrist-watch is a common and accurate measuring instrument used in everyday life.
- Small tolerances in the dimensions of the parts of internal combustion engines are required for reducing fuel consumption and exhaust pollution as well as for increasing the engine's lifetime.
- Quality assurance in production processes requires appropriate measurements and an adequate link (traceability) to recognized references (measurement physical standards), as specified in international standards such as ISO 9000.
- A lack of accuracy in radiotherapy equipment may cause radiations capable of harming a patient or failing to produce the desired effects on a cancerous tumor.
- Sensors are used for routinely monitoring the sugar content of fruits in order to permit a timely, productive crop.
- Space exploration requires extremely accurate length and time measurements.
- In a medium-sized industrial country, gasoline measured each year in transactions involving road-side dispensers amounts to tens of billion US dollars.
- Surveys conducted during the last ten years have shown that measurement-related activities account for 3 % to 6 % of the GNP in industrialized countries.

Measurement made possible the birth of science and fostered the scientific progress that contributed to the development of civilization. In turn, the buildup of societies increased the demand for measurements: industrialization brought a wider range of technologies and a greater number and complexity of business transactions; mass production and automation introduced the need for the interchangeability of parts; and urbanization led to larger scales of human interaction.

Metrology is both the science and activity related to measurements. It includes:

- measurement theory
- units of measurement and their physical realization
- characteristics of measuring instruments
- measurement procedures and methods
- persons and organizations involved in implementing measurements

2 Measurement credibility

Anyone directly or indirectly concerned with measurements expects credible measurement results, i.e., results that do not deviate from the value of that which is measured by more than an accepted amount. Measurement credibility depends on a number of interconnected aspects associated with the measurement process, e.g. calibration and traceability, conformity assessment, staff competence, and laboratory proficiency.

3 Metrological infrastructure

A metrological infrastructure is essential for achieving measurement credibility and it consists of elements such as information, education, expertise, material resources, and calibration facilities. These tools make it possible to solve a measurement problem by knowing *what to measure, how to measure it, and how to assess and report the measurement result.* Such infrastructures exist in most countries and are also present in specific fields such as mechanical engineering, environmental monitoring, and medical diagnosis and treatment.

Whatever the number, size, or specialization of metrological infrastructures, they must work in a uniform and harmonized manner. For example, aircraft components manufactured in different countries must have dimensional and mechanical characteristics that have been measured in a consistent manner; otherwise, the final assembly would be impossible. Such consistency is ensured through cooperation among the national metrology infrastructures at international and regional levels.

4 Governmental role in metrology

In any given country, governmental authorities are involved in activities aimed at encouraging economic development, ensuring the health and safety of the population, supporting education and research, monitoring national competitiveness, and initiating other actions related to public interest. In the field of metrology, governmental responsibility may be considered as the need to ensure the correct operation of a metrological infrastructure intended to provide certain safeguards for the population.

The governmental role in metrology mainly includes the following:

- Definition of compatible units of measurement
- Maintenance of national measurement standards for length, mass, time, etc., and assurance of their uniformity with similar measurement standards in other countries
- Organization of metrological links (traceability) between national measurement standards and measurement processes
- Establishment of legal metrology
- Establishment of accreditation systems for metrology laboratories
- Participation in the development of metrological research, training, and information

National metrology services are generally responsible for carrying out this role. However, metrology extends into areas such as research and development, industry, trade, medicine, occupational safety, and environmental control; it also covers accuracy levels which range from those of primary measurement standards to those of ordinary measuring instruments. Given this broad scope of application, different bodies may be responsible for handling specific metrological matters. In such cases, national metrology services act to coordinate various activities in order to achieve the necessary harmony in metrology.

5 Legal metrology

Certain applications of metrology focus on the need for confidence and equity in measurements which directly concern the public. Legal metrology addresses such needs mainly through regulations (or through contracts) which are implemented to ensure an appropriate level of credibility in measurement results. Measurement credibility is especially necessary whenever conflicting interests exist, or whenever incorrect measurements pose adverse risks for individuals or society. This explains the need for governmental interest in legal metrology activities.

Legal metrology originated from the need to ensure fair trade. One of its most important contributions to society is its role in increasing efficiency in commerce by maintaining confidence in measurements and reducing transaction costs. The need to protect society in health, safety, and environmental protection has also led to important legal metrology developments in these areas.

In all its applications, legal metrology covers measurement units, measuring instruments, and other matters such as prepacked products. With regard to measuring instruments, legal metrology specifies performance requirements, verification procedures, means for ensuring traceability to legally-defined measurement units, and mandatory guidelines for use.

Legal metrology regulations are implemented by or on behalf of a legal metrology department that is preferably part of a national metrology service, or at least closely connected to it. In some countries, however, the responsibilities of the legal metrology department are limited to trade, therefore resulting in the implementation of certain metrology regulations (e.g. for safety or environmental protection) by other bodies. There is nevertheless a need for a uniform application of the metrological provisions for measurement units, traceability, and metrological control and in some cases, a single body may be effective in coordinating the activities of other national legal metrology bodies.

6 International cooperation

Internationalization is an essential characteristic of measurement: international trade determines the world's economy; scientific, technological, and medical research depends on international cooperation; and pollutant emissions are not contained in national borders. Since measurement constitutes a foundation for many activities within these parameters, international exchanges of knowledge and expertise are important steps toward progress in a diversity of sectors.

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A number of international institutions deal with metrology in areas such as standardization, accreditation, certification, physics, chemistry, and health. In order to address metrological subjects of special concern to governments, international intergovernmental cooperation in metrology has been established through the Metre Convention and the International Organization of Legal Metrology (OIML). The Metre Convention is mainly responsible for defining an international system of measurement units (the S.I.) and maintaining international measurement standards for establishing links with corresponding national standards. The objective of OIML is to establish the cooperation necessary for addressing legal metrology matters of international interest. The elimination of technical barriers that result from non-harmonized national metrology regulations is a particular concern for OIML.

The bodies of the Metre Convention and OIML maintain close liaisons with other international and regional bodies concerned with metrology and it is through this cooperation that international metrology issues can be addressed and resolved.

Part 3 OIML strategy

> **"In today's society there exists a vast, often invisible, infrastructure of services, supplies, transport and communication networks. Their existence is usually taken for granted but their presence and smooth operation are essential for everyday life. Part of this hidden infrastructure is metrology, the science of measurement. Confidence in measurement enters into our life in a multitude of ways..."**
>
> *T. J. Quinn "Metrology. Its role in today's world", October 1993.*

1 Introduction

There are a variety of tools that may be used for ensuring measurement credibility. For a given measurement, the appropriate tool must be chosen, and this choice is based on a number of factors such as the necessary accuracy to be obtained within acceptable ranges of uncertainty, measurement cost, quality of the measuring instrument, efficiency of the measurement procedure, and expertise of those who perform the measurement.

Legal metrology is one of these tools. It is applied in fields where conflicting interests may exist with regard to measurement results, or where incorrect measurement results may adversely affect individuals or the society. Legal metrology is the *entirety of the legislative, administrative and technical procedures established by, or by reference to, public authorities and implemented on their behalf in order to specify and to ensure, in a regulatory or contractual manner, the appropriate quality and credibility of measurements related to official controls, trade, health, safety, and the environment.*

2 International harmonization

The harmonization of legal metrology concepts, requirements, and procedures is an ongoing process. Legal metrology may differ from country to country by the following:

- **Extent of its application**

  In some countries, metrology regulations cover only a part of the applications in trade, health, safety, and environmental monitoring whereas in others, a wider range of applications are covered by regulations, e.g. standard measuring instruments and measuring instruments used in industrial processes.

- **Nature of the national bodies responsible for legal metrology implementation**

  There are countries in which a national legal metrology service is only responsible for limited applications of legal metrology (for example, instruments used for retail trade). In such cases, other national bodies are charged with the implementation of regulations concerning measuring instruments used in the fields of health, safety, and the environment.

- **Nature of the requirements**

  Legal metrology requirements may exist either as regulations or as standards developed by different national bodies having different international liaisons.

- **Metrological content of the requirements**

  OIML Recommendations are implemented to various degrees.

- **Application of the requirements**

  Identical requirements may be interpreted and implemented differently.

- **Degree of economic and technical development of countries, and extent of resources available for legal metrology**

The objectives outlined by the GATT and other related regional agreements for the removal of trade barriers, particularly those of a technical nature, make it necessary to accelerate the harmonization of legal metrology requirements and their implementation. Simultaneously, there is a trend towards privatization and deregulation of legal metrology at the national level; this could result in an increase in the number of bodies charged with legal metrology implementation, or it could also replace regulations by other categories of provisions, thereby risking new types of trade barriers. This new approach to the implementation of legal metrology requires international harmonization.

These are the challenges OIML is facing. A clear definition of objectives and strategic action is therefore necessary for successfully meeting these challenges.

3 Objectives

In order to achieve the international harmonization of legal metrology, OIML has the following objectives:

- To contribute to the global recognition of metrology as an essential infrastructure for scientific, industrial, and economic development.
- To maintain leadership in the international development and harmonization of legal metrology activities.
- To promote legal metrology as an important tool for specifying and ensuring appropriate levels of credibility for measurement results in all fields of public interest including trade, health, safety, and the environment.
- To eliminate technical trade barriers that result from non-harmonized national metrology regulations or from non-harmonized procedures for implementing harmonized regulations.
- To promote the manufacture and use of measuring instruments complying with OIML Recommendations.
- To promote national, regional, and international cooperation among legal metrology services and other bodies responsible for various aspects of metrology, e.g. testing and certification of measuring instruments, accreditation of calibration and testing laboratories, and manufacturer's quality systems registration.
- To promote mutual confidence and recognition of measurement and test results performed in accordance with OIML Recommendations.
- To advise OIML Members, and especially those undergoing development, on all matters related to carrying out legal metrology activities.

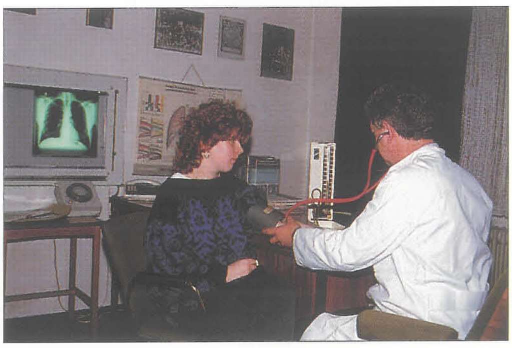
4 Strategy

A strategy has been developed with a view to fulfilling these objectives; it includes general actions to be taken with regard to policy decisions, and a technical strategy focusing on the development and implementation of OIML International Recommendations and Documents.

4.1 General

- Keep governmental authorities informed of OIML objectives and policies in order to obtain their support for active participation of relevant national bodies in OIML activities.
- Encourage the participation of manufacturers and users of measuring instruments, as well as other interested parties, in OIML activities.
- Establish liaisons and cooperation with relevant international and regional institutions with a view to defining and implementing procedures for eliminating duplication of work and ensuring necessary compatibility between activities.

- Encourage regional cooperation and coordination in legal metrology among relevant regional bodies.
- Establish and promote implementation of general rules ensuring the integrity in measurements performed for legal metrology purposes, in particular when using third party accreditation and certification.
- Promote the adoption of OIML technical publications as national regulations or voluntary specifications, where appropriate.
- Develop means, e.g. intercomparisons and training, for promoting mutual confidence in test results among OIML Members.
- Promote the OIML Certificate System and encourage the recognition of certificates and their use in order to facilitate and accelerate the granting of national or regional pattern approvals; develop the System for possible application to individual instruments; and take actions in case of misuse of the System.
- Develop OIML communications through publications such as the OIML Bulletin and other informative brochures.
- Conduct technical seminars with a view to defining a basis for OIML work programs, disseminating information, and promoting cooperation within the metrological community.



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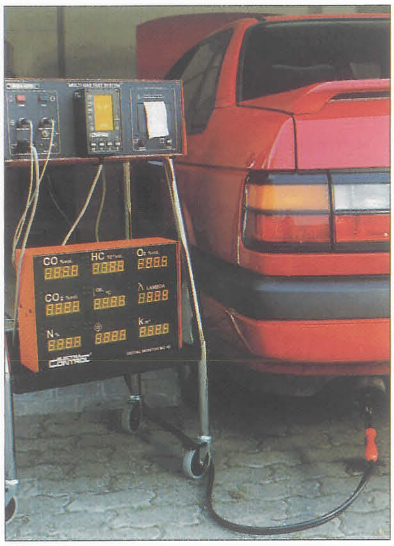
- Advise CIML Members, upon their request, about the establishment of appropriate legal metrology infrastructures.
- Address specific needs of developing countries by implementing programs of the OIML Development Council, developing guidance in fields in which OIML is competent, and encouraging and promoting financial or technical assistance for metrological development.
- Take into consideration reports concerning the economic impacts of legal metrology.
- Encourage the establishment and use of proficiency testing and accreditation as applied to manufacturers of measuring instruments and to laboratories for testing and verifying measuring instruments.

4.2 Technical

- Periodically review, for confirmation or revision, the work program of OIML technical committees and subcommittees and establish priorities as appropriate.
- Accelerate the development of new Recommendations or the revision of existing Recommendations which cover measuring instruments used for applications of an urgent nature, as identified by national legal metrology services, the public, manufacturers and users of instruments, or other international and regional bodies. This can be carried out directly or by reference to existing international standards and applies to measuring instruments in the following fields :

Trade
Automatic weighing instruments, measuring systems for liquids, gas meters, water meters, electronic taximeters



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Safety
Breath testers, occupational-safety measuring instruments, dosimetry instruments

Environment
Instruments for measuring pollutants in air, water, and soil

Health
A variety of clinical and medical measuring instruments

- Review publications that are more than five years old and decide whether to reaffirm, revise or withdraw them.
- Ensure that every new and revised Recommendation contains provisions for testing and reporting test results.
- Rapidly extend the application of the OIML Certificate System to instruments such as automatic weighing instruments, vehicle exhaust emissions measuring instruments, liquid meters, gas meters, taximeters, instruments for measuring pollutants, and medical instruments.
- Develop general guidelines for harmonizing national activities related to pattern evaluation, verification, and supervision, including new procedures such as quality assurance and principles of instrument verification by sampling.

- Develop guidelines for assisting Members of the International Committee of Legal Metrology (CIML) in encouraging national participation in the technical work of OIML, e.g. participation of bodies related to accreditation and certification.

5 Assessment

Strategy is a dynamic concept and the resulting actions must be reviewed and revised as appropriate. In order to monitor the success of the OIML strategy, CIML will assess the progress of certain activities in accordance with a set time period *(see table)*. In addition, BIML will conduct inquiries from time to time among OIML Members and relevant international and regional bodies with a view to obtaining input concerning OIML activities. On the basis of such inquiries, CIML will consider possible reorientations of the OIML strategy.

The complete text of the OIML long-term policy (Parts 1, 2 and 3) may be obtained from BIML.

Assessment of OIML strategy and activities

Item to be evaluated	Time period
• Number of OIML Members	Every four years
• Number of new and revised OIML Recommendations, Documents, and other publications issued	Every year
• Number and effectiveness of participation of OIML Members in technical committees and subcommittees	Every year
• Number and effectiveness of liaisons with other international and regional bodies	Every year
• Degree of implementation of OIML Recommendations by OIML Members	Every four years
• Number of categories of measuring instruments covered by the OIML Certificate System	Every two years
• Number of OIML certificates issued	Every year
• Degree of acceptance of OIML certificates by OIML Members	Every two years
• Number of subscribers to the OIML Bulletin and purchasers of OIML publications	Every year
• Number of technical seminars and participants	Every two years
• Number and type of activities in support of development	Every two years

POLITIQUE A LONG TERME DE L'OIML

Partie 1 Métrologie

1 Introduction

La mesure fournit une description quantitative d'un très large éventail de produits et d'activités. Elle constitue ainsi la base de décisions s'appliquant à notre vie quotidienne dans des domaines aussi vastes et nombreux que le commerce, les sciences et la technologie, l'industrie, l'agriculture, la santé ou la sécurité.

Quelques exemples de l'impact des mesurages sur la société

- Une montre-bracelet est un instrument de mesure usuel et exact, utilisé dans la vie de tous les jours.
- De très faibles tolérances dans les dimensions des pièces d'un moteur à combustion sont nécessaires à la réduction de consommation de carburant et d'émission de gaz d'échappement ainsi qu'à l'augmentation de la durée de vie du moteur.
- L'assurance de qualité dans les processus de production exige des mesurages appropriés et un rattachement adéquat (traçabilité) à des références reconnues (étalons), comme spécifié dans des normes internationales telles que ISO 9000.
- Un manque d'exactitude dans les équipements de radiothérapie peut conduire à des radiations qui risquent de porter atteinte au malade ou au contraire de ne pas avoir les effets désirés sur une tumeur cancéreuse.
- Des capteurs sont couramment utilisés pour contrôler la teneur en sucre des fruits et permettre leur récolte en temps utile.
- L'exploration de l'espace nécessite des mesurages extrêmement précis de longueur et de temps.
- Dans un pays industrialisé de taille moyenne, le prix du carburant mesuré annuellement lors de transactions qui mettent en oeuvre des pompes à essence s'élève à plusieurs dizaines de milliards de dollars US.
- Des études effectuées au cours des dix dernières années ont montré que, dans les pays industrialisés, les activités liées aux mesurages représentent 3 % à 6 % du PNB.

La mesure a permis aux sciences de naître et a favorisé le progrès scientifique, lequel a contribué au développement de la civilisation. En retour, l'édification des sociétés a accru les demandes en matière de mesurages: l'industrialisation a apporté une gamme toujours plus large de technologies et une complexité et un nombre toujours plus grands de transactions commerciales; la production de série et l'automatisation ont créé le besoin d'interchangeabilité des composants; enfin l'urbanisation a élargi les interactions humaines.

La métrologie, à la fois science et activité de la mesure, comprend:

- la théorie de la mesure
- les unités de mesure et leur réalisation physique
- les caractéristiques des instruments de mesure
- les méthodes et procédures de mesure
- les personnes et organismes concernés par les applications de la mesure

2 Crédibilité des mesurages

Toute personne impliquée directement ou non dans des mesurages s'attend à des résultats de mesure crédibles, autrement dit que les résultats ne s'écartent pas de la valeur de ce que l'on mesure de plus qu'une certaine quantité acceptée. La crédibilité des mesurages dépend d'un certain nombre d'aspects liés entre eux et au processus de mesure: étalonnage et traçabilité, assurance de conformité, compétence du personnel, compétence du laboratoire.

3 Infrastructure métrologique

Une infrastructure métrologique est essentielle pour obtenir la crédibilité des mesurages; elle est faite d'éléments tels que information, éducation, savoir-faire, ressources matérielles, moyens d'étalonnage. Ces outils permettent de résoudre un problème de mesure en sachant *quoi mesurer, comment le mesurer, et comment évaluer et formuler le résultat de mesure*. De telles infrastructures existent dans la plupart des pays ainsi qu'au niveau de domaines spécifiques comme l'ingénierie, le contrôle de l'environnement, ou les diagnostiques et traitements médicaux.

Quels que soient le nombre, la taille, ou la spécialisation des infrastructures métrologiques, elles doivent opérer de façon uniforme et harmonisée. Par exemple, les différentes parties d'un avion, fabriquées en des pays différents, doivent avoir des caractéristiques dimensionnelles et mécaniques qui ont été mesurées de façon consistante; sinon, l'assemblage final en serait impossible. Cette consistance est assurée par une coopération, aux niveaux international et régional, entre les infrastructures métrologiques nationales.

4 Implication gouvernementale en matière de métrologie

Dans tout pays les autorités gouvernementales sont impliquées dans des activités qui visent à encourager le développement économique, à assurer la santé et la sécurité de la population, à encourager l'éducation et la recherche, à contrôler la compétitivité nationale, et à initier les actions d'intérêt public. Dans le domaine de la métrologie, la responsabilité gouvernementale peut être considérée comme consistant à satisfaire le besoin d'assurer un fonctionnement correct d'une infrastructure métrologique destinée à fournir certaines protections à la population.

L'implication gouvernementale en métrologie couvre principalement les sujets suivants:

- Définition d'unités de mesure compatibles entre elles
- Maintien des étalons nationaux de longueur, masse, temps, etc. et garantie de leur conformité aux étalons similaires des autres pays
- Constitution de liens métrologiques (traçabilité) entre étalons et processus de mesure
- Établissement de la métrologie légale
- Création de systèmes d'accréditation des laboratoires de métrologie
- Participation aux développements de la recherche, de l'enseignement et de l'information en matière de métrologie

En général, cette implication se traduit par l'existence de services nationaux de métrologie. Cependant, la métrologie s'étend sur un vaste domaine: recherche et développement, industrie, commerce, médecine, sécurité sur les lieux de travail, environnement; elle couvre également des niveaux d'exactitude très différents, depuis les étalons primaires jusqu'aux instruments de mesure ordinaires. En raison de ce large éventail d'applications, plusieurs organismes peuvent être responsables de domaines spécifiques de la métrologie. Le service national de métrologie agit alors pour coordonner ces diverses activités et obtenir la nécessaire harmonie.

5 Métrologie légale

Certaines applications de la métrologie mettent l'accent sur le besoin de confiance et d'équité dans les mesurages d'intérêt direct pour le public. La métrologie légale répond à ce besoin principalement par le biais de réglementations (ou de contrats) mises en application pour assurer un niveau de crédibilité approprié aux résultats de mesure. La crédibilité des mesurages est tout spécialement nécessaire lorsque des intérêts conflictuels existent, ou chaque fois que des mesurages incorrects créent des risques pour les individus ou la société. Cela explique le besoin d'un intérêt gouvernemental dans les activités de métrologie légale.

La métrologie légale est née du besoin d'assurer la loyauté des transactions commerciales et l'une de ses plus importantes contributions à la société est le rôle qu'elle a joué dans l'augmentation de l'efficacité du commerce, en maintenant la confiance dans les mesurages et en réduisant le coût des transactions. Le besoin de protéger la société en ce qui concerne la santé, la sécurité, et la protection de l'environnement a aussi conduit à d'importants développements de la métrologie légale dans ces domaines.

Dans toutes ses applications, la métrologie légale couvre les unités et instruments de mesure et d'autres sujets comme les produits préemballés. En ce qui concerne les instruments de mesure, la métrologie légale spécifie les exigences sur leurs performances, les procédures de vérification, les moyens pour assurer leur traçabilité aux unités de mesure légalement définies, et les instructions obligatoires quant à leur utilisation.

Les réglementations de métrologie légale sont mises en application par ou au nom d'un département de métrologie légale, faisant de préférence partie du service national de métrologie ou au moins étroitement lié à celui-ci. Dans certains pays cependant, les responsabilités du département de métrologie légale sont limitées au commerce, ce

Photo PTB

qui fait que la mise en application de certaines réglementations métrologiques (par exemple pour la sécurité ou la protection de l'environnement) est à la charge d'autres organismes. Il y a néanmoins un besoin d'uniformité dans la mise en application des dispositions métrologiques relatives aux unités de mesure, à la traçabilité, et aux contrôles métrologiques et, dans certains cas, un organisme unique peut constituer une solution efficace pour coordonner les activités des autres organismes nationaux de métrologie légale.

6 Coopération internationale

L'internationalisation est une caractéristique essentielle de la mesure: le commerce international définit l'économie mondiale; la recherche dans les domaines des sciences, de la technologie, et de la médecine repose sur la coopération internationale; quant aux émissions de polluants, elles ne sont pas contenues par les frontières nationales. Etant donné que la mesure constitue une base de nombreuses activités liées à ces domaines, les échanges internationaux de connaissance et de savoir-faire sont des étapes importantes vers le progrès dans de très nombreux secteurs.

Un certain nombre d'institutions internationales s'occupent de métrologie dans des domaines tels que ceux de la normalisation, l'accréditation, la certification, la physique, la chimie, la santé. Afin de traiter des sujets métrologiques d'intérêt spécial pour les gouvernements, une coopération internationale et intergouvernementale en métrologie a été établie à travers la Convention du Mètre et l'Organisation Internationale de Métrologie Légale (OIML).

La Convention du Mètre est principalement responsable de la définition d'un système international d'unités de mesure (le S.I.) et du maintien d'étalons de mesure internationaux auxquels sont liés les étalons nationaux correspondants. L'objectif de l'OIML est d'établir la coopération nécessaire à la solution des questions de métrologie légale d'intérêt international. L'élimination des barrières techniques résultant de réglementations métrologiques nationales non harmonisées est un sujet d'intérêt particulier pour l'OIML.

Les organes de la Convention du Mètre et l'OIML maintiennent des liens étroits avec les autres organismes internationaux et régionaux concernés par la métrologie: c'est à travers cette coopération que les questions de métrologie de caractère international peuvent être abordées et résolues.

Partie 3 Stratégie de l'OIML

“ Dans la société d'aujourd'hui existe une vaste et souvent invisible infrastructure de services et de réseaux d'approvisionnement, de transport et de communication. Leur existence est en général considérée comme donnée bien que leur présence et leur fonctionnement soient essentiels pour la vie de tous les jours. La métrologie, science de la mesure, constitue une partie de cette infrastructure cachée. La confiance dans les mesurages fait partie de notre vie de multiples façons... ”

T.J. Quinn "Metrology. Its role in today's world", octobre 1993 (traduction par le BIML).

1 Introduction

De nombreux outils peuvent être utilisés pour assurer la crédibilité des mesurages. Pour un mesurage donné, l'outil approprié doit être choisi sur la base d'un certain nombre de facteurs tels que l'exactitude que l'on veut atteindre avec une limite d'incertitude acceptable, le coût du mesurage, les qualités de l'instrument de mesure, l'efficacité de la procédure de mesure, et le savoir-faire de ceux qui accomplissent le mesurage.

La métrologie légale constitue l'un de ces outils. Elle s'applique dans les domaines où des intérêts conflictuels peuvent exister vis-à-vis de résultats de mesurage, ou lorsque des résultats de mesurage incorrects peuvent affecter des individus ou la société. La métrologie légale est constituée par *la totalité des procédures législatives, administratives et techniques établies par les autorités publiques, ou par référence à elles, et appliquées en leur nom dans le but de spécifier et d'assurer, de manière réglementaire ou contractuelle, un degré approprié de qualité et de crédibilité dans les mesurages qui concernent les contrôles officiels, le commerce, la santé, la sécurité, et l'environnement.*

2 Harmonisation internationale

L'harmonisation des concepts, exigences, et procédures de métrologie légale est un processus en cours. La métrologie légale peut différer de pays à pays par les éléments suivants:

- **Étendue de son application**

  Dans certains pays, les réglementations métrologiques ne couvrent qu'une partie des applications au commerce, à la santé, à la sécurité, et au contrôle de l'environnement, alors que dans d'autres, une plage plus grande d'applications est couverte par des réglementations qui peuvent, par exemple, s'appliquer aux instruments de mesure étalons et à ceux utilisés dans les processus industriels.

- **Nature des organismes nationaux responsables pour la mise en application de la métrologie légale**

  Il y a des pays dans lesquels le service national de métrologie légale n'est responsable que d'une partie limitée des applications de métrologie légale (par exemple les instruments utilisés pour le commerce de détail). Dans ce cas, d'autres organismes nationaux sont chargés de la mise en application des réglementations sur les instruments de mesure utilisés dans les domaines de la santé, de la sécurité et de l'environnement.

- **Nature des exigences**

  Les exigences en métrologie légale peuvent exister sous la forme soit de réglementations, soit de normes, développées par des organismes nationaux différents qui ont des liaisons internationales différentes.

- **Contenu métrologique des exigences**

  Les Recommandations OIML sont mises en application à des degrés variables.

- **Application des exigences**

  Des exigences identiques peuvent être interprétées et mises en application de façon différente.

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- **Degré du développement économique et technique des pays, et étendue des ressources disponibles pour la métrologie légale.**

Les objectifs fixés par le GATT et autres accords régionaux pour l'élimination des barrières au commerce, en particulier celles de nature technique, rendent nécessaire l'accélération de l'harmonisation des exigences de métrologie légale et de leur mise en application. Il y a simultanément, dans certains pays, des tendances vers la privatisation et la déréglementation du domaine de métrologie légale.

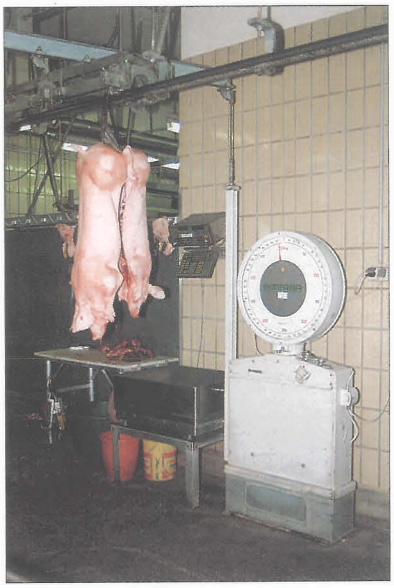
Cela pourrait résulter en un accroissement du nombre des organismes chargés de la mise en application de la métrologie légale, ou encore en un remplacement des réglementations par d'autres catégories de dispositions, avec le risque de création de nouveaux types de barrières au commerce. Cette nouvelle approche de la mise en application de la métrologie légale exige une harmonisation internationale.

Tels sont les défis qui se posent à l'OIML. Une définition claire des objectifs et de la stratégie à suivre est donc nécessaire pour y faire face avec succès.

3 Objectifs

Voici les objectifs de l'OIML, visant à réaliser l'harmonisation internationale de la métrologie légale:

- Contribuer à la reconnaissance globale de la métrologie en tant qu'infrastructure essentielle pour le développement scientifique, industriel et économique.
- Maintenir son leadership dans le développement international et l'harmonisation des activités de métrologie légale.
- Promouvoir la métrologie légale en tant qu'outil important pour spécifier et assurer des niveaux de crédibilité appropriés aux résultats de mesurage dans tous les domaines d'intérêt public, y compris le commerce, la santé, la sécurité, et l'environnement.
- Éliminer les barrières techniques au commerce résultant de réglementations métrologiques nationales non harmonisées ou d'un manque d'harmonisation dans la mise en application des réglementations harmonisées.
- Promouvoir la fabrication et l'utilisation d'instruments de mesure conformes aux Recommandations OIML.
- Promouvoir au niveau national, régional et international, la co-



opération entre services de métrologie légale et autres organismes responsables des divers aspects de la métrologie, par exemple dans les domaines des essais et de la certification des instruments de mesure, de l'accréditation des laboratoires d'étalonnage et d'essai, et de la reconnaissance des systèmes de qualité des fabricants.

- Promouvoir la confiance et la reconnaissance mutuelle des résultats de mesure et d'essai effectués selon les Recommandations OIML.
- Conseiller les Membres de l'OIML, et spécialement ceux qui sont en développement, sur tous les sujets relatifs à l'accomplissement des activités de métrologie légale.

4 Stratégie

Une stratégie a été développée afin d'atteindre les objectifs ci-dessus; elle comprend des actions générales touchant à des décisions de caractère politique, et des actions techniques qui se concentrent sur le développement et la mise en application des Recommandations et Documents Internationaux de l'OIML.

4.1 Actions générales

- Maintenir les autorités gouvernementales informées des objectifs et de la politique de l'OIML afin qu'elles encouragent une participation active des organismes nationaux concernés aux activités de l'OIML.
- Encourager la participation des fabricants et utilisateurs d'instruments de mesure et autres parties intéressées aux activités de l'OIML.
- Établir des liaisons et une coopération avec les institutions internationales et régionales concernées afin de définir et d'appliquer des procédures permettant d'éliminer les doubles emplois et d'assurer la compatibilité nécessaire entre les différentes activités.
- Encourager la coopération et la coordination en matière de métrologie légale entre les organes régionaux concernés.
- Établir des règles générales visant à assurer la qualité globale des mesurages effectués dans le cadre de la métrologie légale, en particulier dans le cas d'accréditation et de certification par tierce partie; promouvoir la mise en application de ces règles par les Membres de l'OIML.
- Promouvoir l'adoption des publications techniques de l'OIML comme réglementations nationales ou spécifications volontaires, selon le cas.
- Développer des moyens, par exemple les intercomparaisons et l'éducation, permettant de promouvoir la confiance mutuelle dans les résultats d'essai entre les Membres de l'OIML.
- Promouvoir le Système de Certificats OIML et encourager la reconnaissance des certificats et leur utilisation pour faciliter et accélérer la délivrance d'approbations de modèle nationales ou régionales; développer le Système en vue de son éventuelle application aux instruments individuels; réagir à toute utilisation inappropriée du Système.
- Développer la politique de communication de l'OIML par des publications telles que le Bulletin OIML et autres brochures informatives.
- Organiser des séminaires techniques pour définir les bases des programmes de travail de l'OIML, disséminer l'information, et promouvoir la communication au sein de la communauté métrologique.
- Conseiller, sur leur demande, les Membres de l'OIML sur l'établissement d'infrastructures de métrologie légale appropriées.
- Examiner les besoins spécifiques aux pays en développement en mettant en application les programmes définis par le Conseil de Développement de l'OIML, en préparant des guides dans les domaines de la compétence de l'OIML, et en encourageant et promouvant une assistance financière et technique en faveur du développement de la métrologie.
- Prendre en considération les rapports relatifs aux impacts économiques de la métrologie légale.
- Encourager l'établissement et l'utilisation des techniques de contrôle de compétence et d'accréditation appliquées aux constructeurs d'instruments de mesure et aux laboratoires d'essai et de vérification des instruments de mesure.

4.2 Actions techniques

- Réexaminer périodiquement, pour confirmation ou révision, le programme de travail des comités techniques et sous-comités

OIML et établir les priorités appropriées.

- Accélérer le développement de nouvelles Recommandations et la révision des Recommandations existantes couvrant les instruments de mesure utilisés dans les domaines présentant un caractère d'urgence pour les services nationaux de métrologie légale, le public, les fabricants et utilisateurs d'instruments, ou autres organismes internationaux et régionaux. Ce travail peut s'effectuer soit directement, soit par référence à des normes internationales existantes, et s'applique aux instruments de mesure utilisés dans les domaines suivants:

  Commerce
  Instruments de pesage à fonctionnement automatique, ensembles de mesurage de liquides, compteurs de gaz, compteurs d'eau, taximètres électroniques

  Sécurité
  Ethylomètres, instruments de mesure pour la sécurité sur les lieux de travail, dosimètres

  Environnement
  Instruments de mesure des polluants de l'air, de l'eau et du sol

  Santé
  Divers instruments de mesure à usage médical et clinique

- Réexaminer les publications vieilles de plus de cinq ans et décider s'il convient de les confirmer, de les réviser ou de les annuler.

- Faire en sorte que chaque Recommandation nouvelle ou révisée contienne des dispositions pour les essais et les rapports d'essai.

- Étendre rapidement l'application du Système de Certificats OIML aux instruments tels que les instruments de pesage à fonctionnement automatique, les instruments de mesure des gaz d'échappement des véhicules, les compteurs de liquides, les compteurs de gaz, les taximètres, les instruments de mesure des polluants, les instruments médicaux.

- Développer des guides généraux pour harmoniser les activités nationales relatives à l'essai de modèle, à la vérification et à la surveillance, en y incluant les nouvelles procédures telles que l'assurance de qualité et les principes gouvernant la vérification statistique des instruments.

- Développer des guides aidant les Membres du Comité International de Métrologie Légale (CIML) à encourager la participation nationale dans les travaux techniques de l'OIML, par exemple celle des organismes travaillant dans les domaines de l'accréditation et de la certification.

5 Evaluation

Toute stratégie constitue un concept dynamique et les actions qui en résultent doivent être réexaminées et réorientées chaque fois que nécessaire. Afin de suivre le succès de la stratégie de l'OIML, le CIML évaluera le progrès de certaines activités à intervalles réguliers (voir tableau). De plus, le BIML effectuera de temps en temps des enquêtes auprès des Membres de l'OIML et des organismes internationaux et régionaux concernés afin d'obtenir leurs vues sur les activités de l'OIML. Sur la base de ces enquêtes, le CIML examinera les besoins de réorientatation de la stratégie de l'OIML.

Le texte complet de la politique à long terme de l'OIML (parties 1, 2 et 3) est disponible auprès du BIML.

Evaluation de la stratégie et des activités de l'OIML

Points à évaluer	Intervalle de temps
• Nombre de Membres de l'OIML	Tous les quatre ans
• Nombre de Recommandations, Documents et autres publications nouvelles et révisées	Tous les ans
• Nombre et degré de participation des Membres de l'OIML aux comités techniques et sous-comités	Tous les ans
• Nombre et réalité des liaisons avec d'autres organismes internationaux et régionaux	Tous les ans
• Degré de mise en application des Recommandations OIML par les Membres de l'OIML	Tous les quatre ans
• Nombre de catégories d'instruments de mesure couvertes par le Système de Certificats OIML	Tous les deux ans
• Nombre de certificats OIML délivrés	Tous les ans
• Degré d'acceptation des certificats OIML par les Membres de l'OIML	Tous les deux ans
• Nombre d'abonnés au Bulletin OIML et d'acheteurs de publications OIML	Tous les ans
• Nombre de séminaires techniques et de participants	Tous les deux ans
• Nombre et type des activités d'aide au développement	Tous les deux ans

FEATURE ON REGIONAL COOPERATION: ASIA PACIFIC

Asia Pacific Legal Metrology Forum

J. BIRCH
Executive Director of the National Standards Commission, Australia

The inaugural meeting of the Asia Pacific Legal Metrology Forum was held in Sydney, Australia 27–30 Nov. 1994. The Legal Metrology Forum is the fifth technical infrastructure regional organisation to be established in the Asia Pacific region.

Other regional organisations cover physical standards of measurement (Asia Pacific Metrology Program – APMP), laboratory accreditation (Asia Pacific Laboratory Accreditation Cooperation – APLAC), standardisation (Pacific Asia Standards Congress – PASC), certification (Pacific Accreditation Cooperation – PAC).

Participating in the inauguration of the Asia Pacific Legal Metrology Forum, *from left to right:* J. Birch, Executive Director of the Australian National Standards Commission; Prof. Julian Goldsmid, Chairman; and B. Athané, Director of *BIML.*

Asia Pacific Economic Cooperation (APEC)

The Asia Pacific regional technical organisations have seen a marked increase in the importance of their role since the formation of APEC - the Asia Pacific Economic Cooperation in 1989. APEC membership now comprises eighteen economies viz Chile, Mexico, USA, Canada, Japan, Republic of Korea, China, Chinese Taipei, Hong Kong, Thailand, Malaysia, Singapore, Indonesia, Brunei, Philippines, Papua-New Guinea, Australia and New Zealand with a combined population of over 2 000 million and together they account for nearly half of the worlds total exports.

APEC's aims are to

- raise living standards in the Asia Pacific region through sustained economic development;
- encourage the interflow of goods, services, capital and technology;
- strengthen an open multilateral trading system; and
- bring about regional trade liberalisations.

Following a series of Ministerial meetings between 1989 and 1993 leaders meetings were held in Seattle in November 1993 hosted by President Clinton and at Bogor in November 1994 hosted by President Suharto. The Bogor meeting issued a declaration committing the APEC economies to the goal of free and open trade in the region by 2020 (and by 2010 for the developed economies).

The APEC Committee on Trade and Investment has established a Standards and Conformance Subcommittee which has established a framework for APEC standards and conformance, adopted general principles and key elements for mutual recognition arrangements and identified priority areas for technical infrastructure development. It was recognised that this subcommittee will need to develop a close working relationship with the technical regional organisations if the APEC agenda on standards and conformance was to be advanced in an efficient and effective way.

Inaugural meeting of the Asia Pacific Legal Metrology Forum

The Asia Pacific Legal Metrology Forum was held in Sydney less than two weeks after the APEC leaders meeting in Bogor. Legal metrology authorities in the eighteen APEC economies were invited to attend and thirty representatives from authorities in fourteen economies attended viz USA, Canada, Republic of Korea, China, Japan, Chinese Taipei, Thailand, Malaysia, Singapore, Indonesia, Philippines, Papua-New Guinea, Australia and New Zealand.

M. Bernard Athané, Director of the BIML, also attended as did representatives from APMP and APLAC and observers from Cook Islands, Fiji, Western Samoa, Solomon Islands, Tonga and Vanuatu. The Forum was chaired by Professor Julian Goldsmid, Emeritus Professor of Experimental Physics, University of New South Wales and Chairman of the National Standards Commission.

The Forum was opened by Senator the Honourable Chris Schacht, Minister for Small Business, Customs and Construction which includes responsibility for Australia's technical infrastructure. Senator Schacht stressed that legal metrology, with its responsibilities for measurement and technical regulations, would make an important contribution to the achievement of free and open trade in the region.

M. Bernard Athané addressed the Forum on OIML and the OIML Certificate Scheme. Of the eighteen APEC economies, seven are full members of OIML, seven are corresponding members and four have no relationship with OIML. The Forum affirmed its commitment to cooperate with OIML and promote the use and acceptance of OIML International Recommendations and the OIML Certification Scheme.

The meeting agreed to establish the Asia Pacific Legal Metrology Forum, consistent with the principles of the APEC Head of economies declaration of free and open trade in the region and with certain objectives *(see below)*.

The Forum elected Mr John Birch AM Executive Director of the National Standards Commission to be Convenor of the Forum and Australia to provide the secretariat until 1998.

It is proposed to hold further meetings of the Forum in Beijing on 24 Sept. 1995 and in Vancouver in Nov. 1996. Both of these meetings will be in association with OIML meetings. A meeting of the five Asia Pacific regional organisations will be held in Fukuoka, Japan 6–9 Feb. 1995 to discuss coordination of work programs and to meet with the APEC Standards and Conformance sub committee.

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ASIA PACIFIC LEGAL METROLOGY FORUM

Objectives

- To develop and maintain mutual confidence between legal metrology authorities in the Asia Pacific region.
- To provide a forum for exchanges of information between legal metrology authorities.
- To identify and promote the removal of technical or administrative barriers to trade in the field of legal metrology.
- To promote mutual recognition arrangements between members and with other regional groups and individual nations.
- To cooperate with the International Organisation of Legal Metrology (OIML) and promote the use and acceptance of OIML International Recommendations and other publications as well as the OIML Certification Scheme.
- To collaborate with other regional bodies including APMP, APLAC, PASC and PAC.
- To coordinate regional training courses in legal metrology and facilitate exchanges of staff between authorities.
- To facilitate the provision of cooperation assistance for the development of legal metrology infrastructures.
- The Forum shall perform such tasks as necessary to achieve these objectives. These tasks may include:

i. *Organisation of interlaboratory test comparisons;*
ii. *Establishment of working groups in specific fields of legal metrology;*
iii. *Publication of a Directory of Legal Metrology in the Asia Pacific region and other appropriate publications.*

Work program for 1995

- Form a Working Party to harmonise legislative requirements including compliance assessment for legal metrology
- Form a Working Party on inter-comparison of pattern approval testing of non-automatic weighing instruments and mass standards
- Form a Working Party to identify opportunities for training in legal metrology and exchanges of staff between legal metrology authorities
- Form a Working Party to harmonize requirements for pre-packed articles
- Publication of the *Directory of Legal Metrology in the Asia Pacific*

activities OIML activités

OIML technical activities

1994 Review
1995 Forecasts

Activités techniques OIML

Rapport 1994
Prévisions 1995

The information given on pp. 39–44 is based on 1994 annual reports submitted by OIML secretariats. Work projects are listed for each **active** technical committee and subcommittee together with the state of progress at the end of 1994 and projections for 1995 when appropriate.

Les informations données en pages 39 à 44 sont basées sur les rapports annuels de 1994, fournis par les secrétariats OIML. Les thèmes de travail sont donnés pour chaque comité technique ou sous-comité **actif** avec l'état d'avancement à la fin de 1994 et les prévisions pour 1995, si approprié.

Key to abbreviations used

WD	Working draft (Preparatory stage) *Projet de travail (Stade de préparation)*
CD	Committee draft (Committee stage) *Projet de comité (Stade de comité)*
DR/DD	Draft Recommendation/Document (Approval stage) *Projet de Recommandation/Document (Stade d'approbation)*
Vote	CIML postal vote on the draft *Vote postal CIML sur le projet*
Appr.	Approval or submission to CIML/Conference for approval *Approbation ou présentation pour approbation par CIML/Conférence*
R/D	International Recommendation/Document (Publication stage) For availability: see list of publications *Recommandation/Document International (Stade de publication)* *Pour disponibilité: voir liste des publications*

OIML TECHNICAL ACTIVITIES

	1994	1995
TC 1 Terminology		
Revision V 1: Vocabulary of legal metrology	–	1 CD
TC 2 Units of measurement		
Revision D 2: Legal units of measurement	3 CD	DD
TC 3/SC 1 Pattern approval and verification		
• Initial verification of measuring instruments utilizing the manufacturer's quality system	2 CD	DD
• Revision D 13: Guidelines for bi- or multilateral arrangements for the recognition of test results for pattern evaluations and verifications	WD	1 CD
TC 4 Measurement standards and calibration and verification devices		
• Principles for the selection and expression of metrological characteristics of standards and devices used for calibration and verification	–	WD
• Revision D 5: Principles for the establishment of hierarchy schemes for measuring instruments	–	WD
• Revision D 10: Recalibration intervals of measurement standards and calibration devices	–	WD
• Revision D 23: Principles of the metrological control of devices used for verification	–	WD
• Revision D 6 + D 8: Measurement standards. Requirements and documentation	–	WD
TC 5 Electronic instruments		
Revision D 11: General requirements for electronic measuring instruments	D	–
TC 6 Prepackaged products		
Revision R 79: Information on package labels	2 CD	DR
TC 7/SC 3 Measurement of areas		
Instruments for measuring the areas of leather	4 CD	5 CD
TC 7/SC 4 Measuring instruments for road traffic		
Revision R 55: Speedometers, mechanical odometers and chronotachographs for motor vehicles. Metrological regulations	3 CD	–

OIML TECHNICAL ACTIVITIES	1994	1995
TC 7/SC 5 Dimensional measuring instruments		
Metrological and technical requirements, test procedures and test report format for multi-dimensional measuring instruments for parcels	WD	1 CD
TC 8 Measurement of quantities of fluids		
• Characteristics of standard capacity measures and test methods for measuring systems	R	-
• Pipe provers for testing of measuring systems for liquids	R	-
• Revision R 63: Petroleum measurement tables	R	-
• Vortex meters	D	-
• Glass delivery measures - Automatic pipettes	D	-
TC 8/SC 1 Static volume measurement		
Revision R 85: Automatic level gauges for measuring the level of liquid in fixed storage tanks	CD	DR
TC 8/SC 2 Static mass measurement		
Direct static mass measurement of quantities of liquid, test procedures, test report format	4 CD	DR
TC 8/SC 3 Dynamic volume measurement (liquids other than water)		
• Measuring assemblies for liquids other than water (Revision R 5, R 27, R 57, R 67, R 77)	R	-
• Testing procedures for pattern examination of fuel dispenser for motor vehicles	R	-
TC 8/SC 4 Dynamic mass measurement (liquids other than water)		
Annex to R 105: Test report format for the evaluation of direct mass flow measuring systems for quantities of liquids	R	-
TC 8/SC 5 Water meters		
Revision R 49: Water meters intended for the metering of cold water	WD	WD
TC 8/SC 6 Measurement of cryogenic liquids		
Revision R 81: Measuring devices and measuring systems for cryogenic liquids (including tables of density for liquid argon, helium, hydrogen, nitrogen and oxygen)	1 CD	2 CD

OIML TECHNICAL ACTIVITIES

	1994	1995
TC 8/SC 8 Gas meters		
• Revision R 6: General provisions for gas volume meters	WD	1 CD
• Revision R 31: Diaphragm gas meters	R	–
• Revision R 32: Rotary piston gas meters and turbine gas meters	WD	1 CD
TC 9 Instruments for measuring mass and density		
Revision R 60: Load cells	–	1 CD
TC 9/SC 1 Non automatic weighing instruments		
• Amendment 1 to R 76-1: Metrological and technical requirements - Tests	R	–
• 2nd revision R 76-1	–	1 CD
TC 9/SC 2 Automatic weighing instruments		
• Annex to R 50: Test procedures and test report format for the evaluation of continuous totalizing automatic weighing instruments	DR	Vote Appr.
• Revision R 51: Automatic catchweighing instruments (including test procedures and test report format)	DR	Vote Appr.
• Revision R 61: Automatic gravimetric filling machines	DR	Vote Appr.
• Annex to R 106: Test procedures and test report format for the evaluation of automatic railweighbridges	DR	DR
• Annex to R 107: Test procedures and test report format for the evaluation of discontinuous totalizing automatic weighing instruments	R	–
TC 9/SC 3 Weights		
Annex to R 111: Test procedures and test report format for the evaluation of weights of classes E_1, E_2, F_1, F_2, M_1, M_2, M_3	WD	1 CD
TC 10/SC 2 Pressure gauges with elastic sensing elements		
• Pressure transmitters with elastic sensing elements	WD	WD
• Annex to R 101: Test procedures and test report format for the evaluation of pressure gauges with elastic sensing elements (ordinary instruments)	CD	DR
• Annex to R 109: Test procedures and test report format for the evaluation of pressure gauges with elastic sensing elements (standard instruments)	CD	DR

OIML TECHNICAL ACTIVITIES

	1994	1995
TC 10/SC 4 Material testing machines		
• Requirements for force measuring instruments for verifying material testing machines	WD	1 CD
• Force measuring systems of material testing machines (Revision R 64: General requirements for material testing machines + Revision R 65: Requirements for machines for tension and compression testing)	2 CD	DR Vote
TC 10/SC 5 Hardness standardized blocks and hardness testing machines		
International intercomparison of hardness blocks (Rockwell hardness blocks)	Work in progress	Work in progress
TC 10/SC 6 Strain gauges		
Revision R 62: Strain gauges	–	WD
TC 11 Instruments for measuring temperature and associated quantities		
Revision R 75: Heat meters	–	WD
TC 11/SC 1 Resistance thermometers		
Revision R 84: Resistance-thermometers sensors made of platinum, copper or nickel (for industrial and commercial use) and inclusion of metallic electrical platinum, copper and nickel resistance thermometers with extended range	WD	1 CD
TC 11/SC 2 Contact thermometers		
• Standardized thermometers	WD	1 CD
• Liquid-in-glass thermometers	WD	1 CD
TC 11/SC 3 Radiation thermometers		
• Revision R 18: Visual disappearing filament pyrometers	–	WD
• Revision R 48: Tungsten ribbon lamps for calibration of optical pyrometers	–	WD
TC 13 Measuring instruments for acoustics and vibration		
• Revision R 58 including development of Annex: Test report format for the evaluation of sound level meters	WD	Vote Appr.

OIML TECHNICAL ACTIVITIES

	1994	1995
TC 13 Measuring instruments for acoustics and vibration *(cont.)*		
• Revision R 88 including development of Annex: Test report format for the evaluation of integrating-averaging sound level meters	WD	Vote Appr.
• Annex to R 102: Test procedures and test report format for the evaluation of sound calibrators	R	–
• Revision R 104: Pure-tone audiometers	WD	DR
• Speech audiometers	R	–
TC 14 Measuring instruments used for optics		
• Annex to R 93: Test report format for focimeters	1 CD	DR
• Illuminance meters	WD	1 CD
TC 15 Measuring instruments for ionizing radiations		
Radiochromic film dosimetry system for measuring absorbed dose in products from gamma and electron radiation	1 CD	2 CD
TC 16/SC 1 Air pollution		
• Continuous measuring instruments for NO_x emissions	–	WD
• Continuous measuring instruments for SO_2 emissions	–	WD
• Continuous measuring instruments for CO emissions	–	WD
• Revision R 99: Instruments for measuring vehicle exhaust emissions	–	1 CD
TC 16/SC 2 Water pollution		
• Inductively coupled plasma atomic emission spectrometers for measuring metal pollutants in water	R	–
• Revision R 83: Gas chromatograph - mass spectrometer	–	WD
• Revision R 100: Atomic absorption spectrometers for measuring metal pollutants in water	–	WD
TC 16/SC 3 Pesticides and other toxic substances pollutants		
Revision R 82: Gas chromatographs for measuring pollution from pesticides and other toxic substances	–	WD
TC 16/SC 4 Field measurements of hazardous (toxic) pollutants		
• Portable and transportable X-ray fluorescence spectrometers for field measurements of hazardous elemental pollutants	DR	Vote Appr.
• Air sampling devices for toxic chemical pollutants at hazardous waste sites	WD	1 CD

OIML TECHNICAL ACTIVITIES	1994	1995
TC 16/SC 4 Field measurements of hazardous (toxic) pollutants *(suite)*		
• Fourier transform infrared spectrometers for measurement of hazardous chemical products	WD	1 CD
TC 17/SC 1 Humidity		
The scale of relative humidity of air certified against saturated salt solution	R	–
TC 17/SC 2 Saccharimetry		
• Revision R 14: Polarimetric saccharimeters	R	–
• Refractometers for measuring the sugar content of grap must	CD	Vote
TC 17/SC 3 pH-metry		
Revision R 54: pH-scale for aqueous solutions	2 CD	Vote
TC 17/SC 5 Viscometry		
Reference standard liquids for the calibration and verification of viscometers	CD	CD
TC 17/SC 7 Breath testers		
Breath testers	3 CD	DR
TC 18 Medical measuring instruments		
Ergometers	WD	CD
TC 18/SC 1 Blood pressure instruments		
Revision R 16: Manometers for instruments for measuring blood pressure (sphygmomanometers)	3 CD	4 CD
TC 18/SC 2 Medical thermometers		
• Clinical electrical thermometers for continuous measurement	R	–
• Clinical electrical thermometers with maximum device	R	–
TC 18/SC 5 Measuring instruments for medical laboratories		
Absorption photometers	1 CD	1 CD

activities OIML activités

International Bureau of Legal Metrology

Report on activities: 1994

BIML

ADMINISTRATION

- Distribution of the minutes for the OIML Ninth International Conference of Legal Metrology (Greece, Nov. 1992)
- Distribution of the minutes for the 28th Meeting of the International Committee of Legal Metrology (Germany, Oct. 1993) and implementation of decisions and resolutions
- Administrative work associated with CIML approval of International Recommendations and Documents
- Preparation of a new edition of the brochure *Metrology in OIML Members*

TECHNICAL WORK

Technical committees and subcommittees

- Final organization of TCs/SCs: secretariats, work programs, membership
- Liaisons with other international and regional bodies

Technical publications

- Editorial work on draft Recommendations
- Publication and distribution of eight OIML International Recommendations: R 50, Annex to R 60, Amendment to R 76-1, R 63 and Rs 109–113
- Preparation of new Recommendations for publication

Participation in various seminars, conferences and meetings

- Movement of Non-Aligned Countries (Colombo, Jan. 1994)
- 5th International Symposium on Metrology (Bucharest, May 1994)
- IMEKO TC 11 (Braunschweig, Sept.1994)
- First meeting of the Asia Pacific Legal Metrology Forum (Sydney, Nov. 1994)

OIML CERTIFICATE SYSTEM

- Registration of some forty OIML certificates and information distributed to all bodies concerned
- Establishment of a data base for certificates
- Establishment of a technical advisory group on certification

OIML LONG-TERM POLICY

Participation in finalizing the paper on OIML policy and strategy

COMMUNICATION

- Ensuring exchanges of information between OIML Members and with liaison institutions
- Regional visit to Far East Asiatic Members for studying communication matters with metrology services and other bodies
- Preparation of a brochure on OIML
- Preparation of four issues of the OIML Bulletin and marketing efforts for developing its readership

OIML MEETINGS

- Preparation and organization of the Presidential Council meeting (Paris, Feb. 1994)
- Arrangements for the 29th CIML Meeting (Paris, Oct. 1994) and preparation of documents
- Arrangement for the Development Council Meeting (Paris, Oct. 1994) and preparation of documents
- Participation in OIML technical meetings: TC 11 (Berlin), TC 9 and TC 9/SC 2 (Teddington)

OTHER MEETINGS

- COOMET (Bratislava, Mar. 1994)
- WELMEC and EUROMET (Oslo, May 1994)
- ECE-UNO (Geneva, May 1994 and Paris, Sept. 1994)
- EAL (Paris, May 1994)
- ISO General Assembly and DEVCO (Nice, Sept. 1994)

MAINTAINING LIAISONS WITH INTERNATIONAL INSTITUTIONS

- Commission of the European Communities
- International Standardization Organization (ISO) and International Electrotechnical Commission (IEC)
- United Nations Industrial Development Organization (UNIDO)
- International Union of Pure and Applied Chemistry (IUPAC)
- Comité Européen de Normalisation (CEN) and Comité Européen de Normalisation Electrotechnique (CENELEC)
- European Cooperation in Legal Metrology (WELMEC)
- Metrological Cooperation for Central and Eastern European Countries (COOMET)
- Asia-Pacific Legal Metrology Forum and other Asia-Pacific bodies
- Commonwealth India Metrology Center (CIMET)
- North-American Metrology Cooperation (NORAMET)
- Economical Commission for Europe of the United Nations (ECE-UNO)
- and others

MEETINGS

PRESIDENTIAL COUNCIL

The OIML Presidential Council met at BIML, 31 Jan.–1 Feb. 1995 to discuss various matters concerning the Organisation.

President: G. J. Faber

Vice-Presidents: S. E. Chappell, M. Kochsiek

Participation: S. J. Bennett, J. Birch, L. K. Issaev, B. Athané
as observers: BIML technical agents

Main points

- The composition of the Council was considered; at present it includes six members, three of which occupy the positions of CIML President and Vice-Presidents; the three others have been appointed by the CIML President. It may be envisaged in the future to slightly enlarge the Council's composition.
- Preparations for the seminar on weighing instruments, the symposium for developing countries, the 30th CIML meeting and the 10th Conference were reviewed. A round-table will be organized for the 30th CIML meeting to address "confidence in type approval".
- A report was given on the activities of OIML TCs and SCs; their progress is encouraging for the future of OIML.
- The OIML long-term policy documents and the OIML brochure were discussed;

publication of both documents was set for spring 1995.

- The development of regional cooperation in legal metrology was discussed and OIML policy for this subject must be to encourage such cooperation and to establish close links with regional bodies.
- The Council considered it necessary to prepare a document concerning OIML policy with regard to international and regional organizations, for publication during 1996.

CONSEIL DE PRESIDENCE

Le Conseil de la Présidence de l'OIML s'est réuni au BIML, les 31 janvier et 1er février 1995, pour discuter de différentes questions concernant l'Organisation.

Président: G.J. Faber

Vice-Présidents: S.E. Chappell, M. Kochsiek

Participation: S.J. Bennett, J. Birch, L.K. Issaev, B. Athané *en tant qu'observateurs:* les agents techniques du BIML

Points principaux

- La composition du Conseil a été examinée; il comprend actuellement six membres, dont trois occupent les positions de Président et Vice-Présidents du CIML; les trois autres ont été nommés par le Président du CIML. Cependant, on peut envisager dans le futur d'élargir légèrement la composition du Conseil.
- Les préparatifs du séminaire OIML sur les instruments de pesage, du symposium OIML pour les pays en développement, de la 30e réunion du CIML et de la 10e Conférence, ont été examinés. Une table ronde sera organisée pendant la 30e réunion du CIML pour discuter du thème "confiance dans les approbations de modèle".
- Un rapport sur l'activité des TC et SC OIML a été donné; leur progrès semble encourageant pour l'avenir de l'OIML.
- Les documents sur la politique à long terme de l'OIML et la brochure OIML ont été examinés; la publication de ces documents est prévue pour le printemps 1995.
- Le développement de la coopération régionale en métrologie légale a été discuté et la politique de l'OIML à ce sujet doit être d'encourager la coopération régionale, et d'établir des liens étroits avec les organismes régionaux.
- Le Conseil a jugé nécessaire de préparer un document sur la politique de l'OIML en ce qui concerne les organisations internationales et régionales, pour publication courant 1996.

TC 9/SC 2

Automatic weighing instruments

Secretariat: United Kingdom

The technical subcommittee TC 9/SC 2 held a meeting in Teddington, UK, 13–15 Dec. 1994.

Chairman: Mr D. Jones, NWML

Participation: 14 delegates representing 14 P-members; 4 representatives of industry (Comité Européen des Constructeurs d'Instruments de Pesage, CECIP, and COPAMA, UK); Ph. Degavre from BIML.

Main points

- Revision of OIML R 61 *Automatic gravimetric filling machines*
- A 8th committee draft which included test procedures and the test report format was discussed and submitted for vote. Taking into account many written or oral comments, this committee draft was amended during the meeting and registered as Draft Recommendation with positive votes by the unanimity of the delegates.
- Revision of OIML R 51 *Automatic catchweighers*
- A 7th committee draft which includes test procedures and the test report format was discussed. After having clarified the amendments proposed by the secretariat, particularly those concerning the maximum permissible errors in function of the different intrument categories covered by this Recommendation, the committee draft was amended during the meeting and registered as a Draft Recommendation with positive votes by the unanimity of the delegates.
- Automatic road weighbridges; new OIML Recommendation project
- An initial draft was distributed before the meeting and should be discussed during the next

TC 9/SC 2 meeting, 18–20 Sept. 1995, Paris. This meeting will be hosted by the *Sous Direction de la Métrologie,* after the OIML seminar "Weighing towards the year 2000" organized by BIML, and chaired by S. Bennett, Chief Executive of NWML and Member of the OIML Presidential Council.

Contact information:

Martin Birdseye
National Weights and Measures Laboratory
Stanton Avenue
Teddington, Middlesex TW 11 OJZ
United Kingdom
Tel: 44 81 943 72 74
Fax: 44 81 943 72 70

TC 9/SC 2

Instruments de pesage à fonctionnement automatique

Secrétariat: Royaume-Uni

Le sous-comité technique TC 9/SC 2 a tenu une réunion à Teddington, Royaume-Uni, du 13 au 15 décembre 1994.

Président: M. D. Jones, NWML

Participation: 14 délégués représentant 14 membres-P; 4 représentants de l'industrie (Comité Européen des Constructeurs d'Instruments de Pesage, CECIP et COPAMA); Ph. Degavre du BIML.

Points principaux

- Révision de OIML R 61 *Doseuses pondérales à fonctionnement automatique.*
- Un 8e projet de comité incluant les procédures d'essai et le format de rapport d'essai a été discuté et soumis au vote. Ce projet de comité a été modifié pendant la réunion en tenant compte des différents commentaires écrits ou oraux et a été enregistré comme Projet de Recommandation après un vote positif à l'unanimité des délégués.
- Révision de OIML R 51 *Instruments trieurs-étiqueteurs*
- Un 7e projet de comité incluant les procédures d'essai et le format de rapport d'essai a été discuté. Après avoir clarifié les propositions de modifications du secrétariat, en particulier celles qui concernaient les erreurs maximales tolérées en fonction des catégories d'instrument couvertes par cette Recommandation, ce projet de comité a été modifié pendant la réunion et a également été enregistré comme Projet de Recommandation après un vote positif à l'unanimité des délégués.
- Ponts-bascules routiers à fonctionnement automatique; nouveau projet de Recommandation OIML
- Un projet initial avait été distribué avant la réunion. Il sera discuté au cours de la prochaine réunion du TC 9/SC 2 les 18-20 septembre à Paris. Cette réunion sera organisée par la Sous Direction de la Métrologie, après le séminaire OIML "Le pesage vers l'an 2000", organisé par le BIML, et présidé par S. Bennett, Directeur du NWML et Membre du Conseil de Présidence de l'OIML.

Contact pour information:

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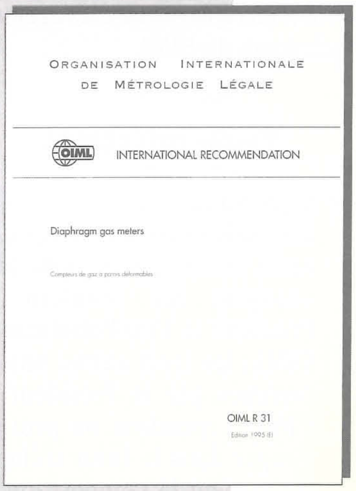
Teddington, Middlesex TW 11 OJZ
United Kingdom
Tél: 44 81 943 72 74
Fax: 44 81 943 72 70

NEW PUBLICATIONS / *NOUVELLES PUBLICATIONS*

R 31	(new edition) Diaphragm gas meters *(nouvelle édition) Compteurs de gaz à parois déformables*
R 76-2 Amendment	Nonautomatic weighing instruments Part 2: Pattern evaluation report *Instruments de pesage à fonctionnement non automatique* *Partie 2: Rapport d'essai de modèle*
R 114	Clinical electrical thermometers for continuous measurement *Thermomètres électriques médicaux pour mesurage en continu*
R 115	Clinical electrical thermometers with maximum device *Thermomètres électriques médicaux avec dispositif à maximum*


Organisation Internationale de Métrologie Légale
OIML International Recommendation
Diaphragm gas meters
OIML R 31

Available in French and English (see OIML Bulletin supplement for price-list).

To order a publication, please contact OIML headquarters:
Bureau International de Métrologie Légale
11, rue Turgot, 75009 Paris, France   Fax: 33 1 42 82 17 27

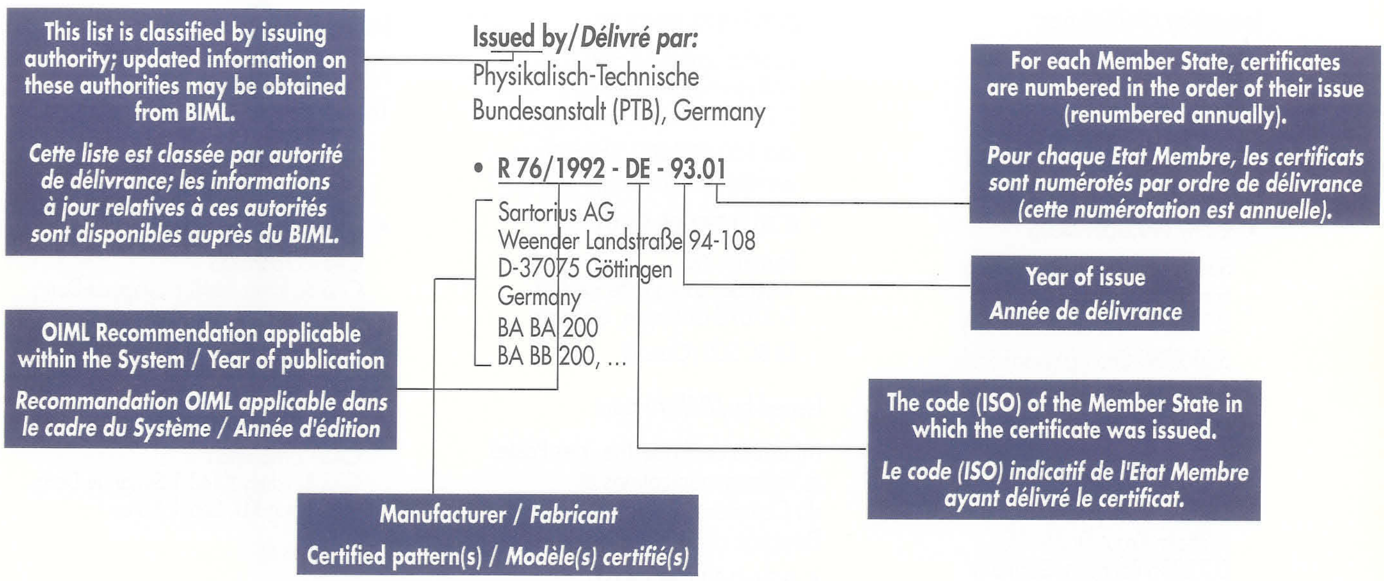
OIML certificate system
OIML
système de certificats OIML

OIML CERTIFICATES registered from December 1994 to February 1995

CERTIFICATS OIML enregistrés de décembre 1994 à février 1995

HOW TO USE THE LIST OF OIML CERTIFICATES

COMMENT UTILISER LA LISTE DES CERTIFICATS OIML



INSTRUMENT CATEGORY Load cells R 60 (1991), Annex A (1993)

CATÉGORIE D'INSTRUMENT Cellules de pesée R 60 (1991), Annexe A (1993)

Issued by/*Délivré par:*

Ministère de l'Industrie, des Postes et Télécommunications et du Commerce Extérieur – Sous-Direction de la Métrologie, France

- **R 60/1991-FR-94.02**

  Scaime SA
  Le Bois de Juvigny, BP 501
  74105 Annemasse, France

  Capteurs à jauges de contrainte Scaime types S30X 300 C..., S30X 600 C..., S30X 1200 C..., and S30X 2500 C... (Class C)

Issued by/*Délivré par:*

National Weights and Measures Laboratory (NWML)
United Kingdom

- **R 60/1991-GB-95.01**

  Sensortronics Inc.
  677 Arrow Grand Circle
  Covina, CA 91722
  USA

  Load Cell Model No Sensortronics 60001C (Class C)

- **R 60/1991-GB-95.02**

  Sensortronics Inc.
  677 Arrow Grand Circle
  Covina, CA 91722, USA

  Load Cell Model No Sensortronics 65023C-S (Class C)

- **R 60/1991-GB-95.03**

  Sensortronics Inc.
  677 Arrow Grand Circle
  Covina, CA 91722, USA

  Load Cell Model No Sensortronics 60050C (Class C)

- **R 60/1991-GB-95.04**
  Sensortronics Inc.
  677 Arrow Grand Circle
  Covina, CA 91722, USA
  Load Cell Model No Sensortronics 60060C (Class C)

- **R 60/1991-GB-95.05**
  Sensortronics Inc.
  677 Arrow Grand Circle
  Covina, CA 91722, USA
  Load Cell Model No Sensortronics 65023C (Class C)

Issued by/*Délivré par:*

NMi IJkwesen B.V.
The Netherlands

- **R 60/1991-NL-94.01**
  Revere Transducers B.V.
  Ramshoorn 7
  4824 AG Breda
  The Netherlands
  HCB (Class C)

- **R 60/1991-NL-94.02**
  HBM Inc.
  19 Barlett St.
  Marlboro, MA 01752, USA
  SDK-400 (Classes C and D)

- **R 60/1991-NL-94.03**
  Epel Industrial S.A.
  Ctra. Sta. Cruz de Calafell,
  35 km. 9,400
  08830 Sant Boi de Llobregat
  Barcelona, Spain
  ATC (Class C)

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

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

Issued by/*Délivré par:*

Physikalisch-Technische Bundesanstalt (PTB), Germany

- **R 76/1992-DE-94.05**
  Soehnle-Waagen GmbH + Co.
  Fornsbacher Straße 27-35
  D 71540 Murrhardt, Germany
  S20-2760 Chair (Person) Scale (Classes III and IIII)

- **R 76/1992-DE-94.08**
  Bizerba GmbH & Co. KG
  Wilhelm-Kraut-Straße 65
  D 72336 Balingen, Germany
  SW 100, SW 200, SW 500 and SW 800 (Class III)

- **R 76/1992-DE-94.09**
  Bizerba GmbH & Co. KG
  Wilhelm-Kraut-Straße 65
  D 72336 Balingen, Germany
  BW 100, BW 200, BW 500 and BW 800 (Class III)

- **R 76/1992-DE-95.01**
  Sartorius AG
  Weenden Landstraße 94-108
  D 37075 Göttingen, Germany
  DI BC 200 (Class II)

Issued by/*Délivré par:*

Ministère de l'Industrie, des Postes et Télécommunications et du Commerce Extérieur – Sous-Direction de la Métrologie, France

- **R 76/1992-FR-95.01**
  Société Precia
  BP 106 07001 Privas Cedex, France
  Precia scale model X922.A (Class III)

Issued by/*Délivré par:*

NMi IJkwesen B.V.
The Netherlands

- **R 76/1992-NL-94.11**
  CAS Corporation
  CAS Building #440.1 Sungnae-Dong.
  Kangdong-KU, Seoul, Korea
  AD (Class III)

- **R 76/1992-NL-94.12**
  CAS Corporation
  CAS Building #440.1 Sungnae-Dong.
  Kangdong-KU, Seoul, Korea
  LP (Class III)

NEW APPLICATIONS FOR OIML CERTIFICATION

The publication of OIML Recommendations R 114 and R 115, *Clinical electrical thermometers for continuous measurement* and *Clinical electrical thermometers with maximum device* results in a wider field of application for OIML certification.

Medical measuring instruments constitute a vast area of development in legal metrology; it is important that these instruments work correctly and reliably, even when used by persons who are not expert in metrology. Medical diagnosis and health care efficiency are partly based on measurements: e.g. body temperature, blood pressure, rapidity of blood cell sedimentation, etc.

OIML certification of medical measuring instruments, beginning with electrical thermometers, will contribute to efforts for assuring the high metrological performance of these necessary tools. A special issue of the OIML Bulletin on medical measuring instruments is planned for the months to come.

Moreover, the new edition of OIML Recommendation R 31 on *Diaphragm gas meters* makes it possible for these instruments to receive OIML certificates. At present, only mechanical meters are concerned, with certification of electronic gas meters possible as soon as the new edition of OIML Recommendation R 6 (now being revised) is published. ■

NOUVELLES APPLICATIONS DE LA CERTIFICATION OIML

Avec la publication des Recommandations OIML R 114 et R 115, *Thermomètres électriques médicaux pour mesurage en continu* et *Thermomètres électriques médicaux avec dispositif à maximum,* le champ d'application de la certification OIML s'étend.

Les instruments de mesure médicaux constituent un vaste domaine de développement de la métrologie légale, en raison de l'importance qu'il y a à ce que ces instruments fonctionnent correctement et de manière fiable même entre les mains de personnes non expertes en matière de métrologie. En effet, les diagnostics médicaux et l'efficacité des soins sont en partie basés sur des mesures: température du corps, pression artérielle, vitesse de sédimentation des globules, etc.

La certification OIML des instruments de mesure médicaux, qui débute avec les thermomètres électriques, contribuera à assurer de bonnes performances métrologiques à ces outils indispensables; le Bulletin OIML consacrera un de ses prochains numéros à l'instrumentation de mesure médicale.

Par ailleurs, avec la publication d'une nouvelle édition de la Recommandation OIML R 31 *Compteurs de gaz à parois déformables,* ces instruments peuvent également faire l'objet de certificats OIML; dans l'immédiat, seuls les compteurs mécaniques seront concernés; les compteurs de gaz électroniques devront, pour pouvoir être certifiés, attendre la publication de la nouvelle édition de la Recommandation OIML R 6, actuellement en cours de révision. ■

Now available: International Vocabulary of Basic and General Terms in Metrology (VIM) in Spanish

PRESENTACIÓN DEL VOCABULARIO

Cuando en marzo de 1984, OIML anuncia que el Vocabulario Internacional de los términos fundamentales y generales de Metrología (VIM) estará disponible en breve plazo y será publicado por el Secretariado Central del ISO, en nombre de las cuatro organizaciones que en aquella época habían participado en su redacción (BIPM, CEI, ISO, OIML), el Centro Español de Metrología acoge con gran interés la sugerencia que le hace la Organización de preparar una traducción al español que facilite así la coordinación terminológica entre todos los organismos, laboratorios, fabricantes de instrumentos de medida, y en general, entre todos aquellos interesados en la Metrología.

Para ello, se constituye dentro del CEM, un Grupo de Trabajo que aborda de immediato un proyecto de traducción que una vez ultimado se remite a los países de habla hispana para que efectuaran los comentarios oportunos al mismo.

Paralelamente se solicitó de organismos españoles tan acreditados como la Real Academia de las Ciencias y la Asociación Española de la Calidad, entre otras, que efectuaran también una traducción para poder llegar a una versión consensuada y conjunta.

Este trabajo quedó momentáneamente paralizado debido al anuncio de una revisión al citado vocabulario por parte del grupo ISO TAG 4. Una vez finalizada esta revisión y disponiendo ya del texto final, el CEM reanudó sus trabajos que han concluido recientemente con la publicación, en español, del citado vocabulario, que esperamos y deseamos constituya un paso más en la armonización de la terminología metrológica en todos los países que hablan nuestra lengua.

METROMED 95

International Scientific and Practical Conference

Measuring information technologies and instruments for health care

20–22 June 1995
St Petersburg, Russia

This Conference is organized by the State Technical University together with the Academy of Metrology, International Scientific and Technical Society of Instruments Engineers and Metrologists.

The main objective of the Conference is to draw the intellectual potential of instrument engineers and metrologists towards finding solutions to the problems of manufacturing medical instruments and to enable the realization of the newest medical technologies.

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STUSP
Polytechnicheskaja str., 29
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Legal metrology cooperation in the South West Pacific

In association with the Asia Pacific Legal Metrology Forum, held in Sydney from 27–30 November 1994, a two-day meeting of legal metrology authorities in the SW Pacific was held at the National Standards Commission in Sydney from 1–2 December 1994.

The meeting was attended by 17 delegates from Cook Islands, Fiji, New Zealand, Papua-New Guinea, Western Samoa, Solomon Islands, Tonga, Vanuata and Australia. Development and harmonisation of legalisation, intercomparisons of mass and volume standards, regional standards and testing facilities and training in legal metrology were addressed.

The Papua-New Guinea delegate Mr Kialou Angat reported on the development of the Papua-New Guinea National Institute of Standards and Industrial Technology. The forum also discussed the problems of small island states in developing effective technical infrastructures, including training in legal metrology.

The meeting recognised that coordination and cooperation would be assisted by improved information flow between authorities. It was agreed to publish a Directory of Legal Metrology in the South West Pacific in 1995 and give consideration to the publication of a newsletter.

The meeting adopted an active program of cooperation for 1995 and aims to hold a further meeting in early 1996 in one of the SW Pacific nations. ■

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9th General Assembly of the African Regional Organization for Standardization

ARSO held its 9th General Assembly at the International Conference Center in Grand' Baie, Mauritius from 23–25 January 1995.

The meeting was opened by the Mauritius Minister of Industry, and assembled delegations from Burkino Faso, Ethiopia, Gana, Kenya, Malawi, Mauritius, Nigeria, Sierra Leone, Sudan, and Uganda, and observers from Lesotho, Mozambique, and South Africa.

Several regional organizations were also represented, including the Economic Commission of the United Nations for Africa; RESOURCE, a British body for assisting development; as well as two international organizations, FAO and OIML.

ARSO's metrological activity mainly consists of organizing training courses (in which OIML has participated on numerous occasions), developing regional metrology centers, elaborating regional metrological standards (often taken from OIML publications), and making African governments more aware of metrology.

B. Athané, Director of BIML, suggested that ARSO develop more regional cooperation in close collaboration with OIML, i.e. by using more OIML publications of interest to African countries; encouraging the use of OIML certified measuring instruments; and participating in OIML activities addressing development matters. ■

9e Assemblée Générale de l'Organisation Régionale Africaine de Normalisation

L'ARSO a tenu sa 9e Assemblée Générale dans l'enceinte du Centre International de Conférence de Grand'Baie, Ile Maurice, du 23 au 25 janvier 1995.

La réunion, ouverte par le Ministre Mauricien de l'Industrie, a rassemblé des délégations de Burkina Faso, Ethiopie, Ghana, Kenya, Malawi, Ile Maurice, Nigéria, Sierra Leone, Soudan, et Ouganda, ainsi que des observateurs de Lesotho, Mozambique et Afrique du Sud.

De nombreuses organisations régionales, dont la Commission Économique pour l'Afrique des Nations-Unies, un organisme britannique d'aide au développement, Resource, ainsi que deux organisations internationales, la FAO et l'OIML, y avaient envoyé des représentants.

L'activité de l'ARSO dans le domaine de la métrologie comprend principalement l'organisation de cours de formation (auxquels l'OIML a participé à plusieurs reprises), le développement de centres métrologiques régionaux, la mise au point de normes métrologiques régionales (bien souvent reprises des publications OIML), et la sensibilisation des gouvernements africains à la métrologie.

B. Athané, le directeur du BIML, a suggéré que l'ARSO développe encore davantage la coopération régionale, en étroite coopération avec l'OIML, c'est-à-dire: en utilisant davantage les publications OIML d'intérêt pour les pays africains; en faisant appel de préférence à des instruments de mesure certifiés OIML; et en s'associant aux activités OIML tournées vers les questions de développement. ■

WELMEC

European cooperation in legal metrology 8th Committee meeting

The European cooperation in legal metrology (WELMEC) held its 8th Committee meeting, hosted by the European Commission, January 12–13 in Brussels.

As explained in previous issues of the OIML Bulletin, this Committee comprises delegates from EC and EFTA national bodies that have signed the Memorandum of Understanding; it is chaired by Dr Seton Bennett, Chief Executive of the National Weights and Measures Laboratory in the UK.

In his opening speech, Dr Bennett explained the substantial progress that was made in 1994 by the WELMEC working groups and announced the future possibility of associating six new European countries with WELMEC activities: Bulgaria, Czech Republic, Hungary, Poland, Romania, and Slovakia.

Main points of the meeting

- *New logo for the Organization*

The name WELMEC was retained, to be accompanied by the words "European cooperation in legal metrology".

- *Extension of the Type Approval Agreement*

It was decided to establish a new working group (WG 9) to oversee the Type Approval Agreement, to analyze a possible extension of the Agreement, and to propose intercomparison exercises.

- *Cooperation between EC notified bodies in the field of measuring instruments*

The European Commission envisages to establish cooperation between notified bodies in sectoral groups by creating technical and administrative secretariats. WELMEC provides the appropriate framework for such a cooperation in legal metrology and indicated to the European Commission its willingness to undertake this work.

- *Publications*

The WELMEC Committee agreed to publish the following documents:

- European legal metrology Directory
- Guide for Examining Software (Non-automatic Weighing Instruments)
- Guide for Testing Indicators (Non-automatic Weighing Instruments)
- Guide for Testing Point of Sale Devices (Non-automatic Weighing Instruments)

- *EMeTAS project: the set-up of a European metrological pattern approval database*

Mr J. A. J. Basten, Director NMi Certin B.V. and Chairman of the WG 3, presented the advances made in preparing the implementation of a European database of EC pattern approval certificates. WG 3 was invited by the Committee to make recommendations for the establishment of a Steering Group (3 or 4 persons from legal metrology services) which will be in charge of supervising EMeTAS (quality of services and management of financial aspects).

- *Additional cooperation*

The Committee invited EAL and EAC to discuss with WG 4 the issues arising from the application of certification and accreditation in legal metrology. ■

39th EOQ ANNUAL CONGRESS

12 – 16 June 1995
Palais de Beaulieu
Lausanne, Switzerland

The 39th Annual Congress of the European Organization for Quality (EOQ) will be organized around four parallel streams and 11 sessions during which almost 100 papers will be presented by authors from 30 different countries.

A half-day workshop on self-assessment will be conducted before the Congress by the European Foundation for Quality Management, on behalf of EOQ.

Main themes of the Congress

Stream A
People for Quality

Stream B
Quality for People

Stream C
Cases and Methods - Country Cases, small and medium size enterprises, advanced methods and practice

Stream D
Cases and Methods - ISO 9000, Company and Branch Cases

Special stream
Food session: safety aspects of food quality

Special Events
Poster session, Exhibition, Quality Garden

Contact information:

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Fax: 41-21-616 86 47

EUROPEAN ORGANIZATION FOR QUALITY

MERA-95

Measuring • Testing •
Medical equipment • Informatics

International Exhibition
with Symposium

20–25 June 1995, Moscow

Organizers

International Scientific-Technical Society of Instrument Engineers and Metrologists

All-Russia Exhibition Centre

Co-organizers

Russian Academy of Sciences

Russian Academy for Medical Sciences

Department for Science and Technical Policy of the Russian Federation Government

Department for Machine Building of the Russian Federation Government

Committee of the President for Informational Policy

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- Indicators
- Weighing instruments
- Medical instruments, apparatus and facilities
- Computers
- Laboratory equipment
- Dentistry
- Biotechnology

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International Scientific and Technical Society of Instruments Engineers and Metrologists
10/2 Mohovaya
121019 Moscow
Tel: 7-095-202 65 71
Fax: 7-095-202 14 73

All-Russia Exhibition Centre
V.V.C., Upravlenie Vneshnih svjazej
129223 Moscow
Tel: 7-095-216 5374
Fax: 7-095-181 64 10

IMEKO CALENDAR

TC 2 Photonic Measurements
15th Symposium on Photonic Measurements
San Diego, CA, USA 9–14 July 1995

TC 3 Measurement of Force and Mass
14th Conference on the State-of-the-Art in Force and Mass Measurements
Warsaw, Poland 11–14 Sept. 1995

TC 4 Measurement of Electrical Quantities
7th Symposium on Modern Electrical and Magnetic Measurement
Prague, Czech Rep. 13–14 Sept. 1995

TC 12 Temperature and Thermal Measurement
4th Thermophysical Workshop on Measurements of Temperature Gradient
Budapest, Hungary 7–9 Nov. 1995

TC 13 Measurements in Biology and Medicine
7th Symposium on Model-Based Bio-measurements
Stará Lesná (High Tatras), Slovakia
6–9 Sept. 1995

Russian metrology publication available in English

Izmeritelnaya Tekhnika (IT) • Measurement Technique (MT)

The monthly scientific-technical magazine *Izmeritelnaya Tekhnika (IT)* was founded in the USSR in 1939. This magazine (and its supplement, *Metrology*) is one of its kind and is devoted to measurement theory and practices. IT addresses not only the problems of Measurement Uniformity Assurance in Science and Technology, but those of Legal Metrology as well.

IT, to some extent, is an encyclopaedic publication for several subjects, including fundamental and general problems of measurements, definite fields of measurements, metrological assurance for the manufacture of products, governmental metrology services, and new principles and methods for the measurement of physical values. IT unifies the efforts of scientists, R & D specialists, professors for the support of measurement activity in Russia on a modern level and was rated in "the Soros list of publications".

In accordance with an agreement between Plenum Publishing Corporation (New York) and Gosstandart (Moscow), IT has been translated and published in English as *Measurement Technique (MT)* since 1958. There are many subscribers throughout the world for both IT (with *Metrology*) and MT (without *Metrology*). Subscriptions for "IT" are handled by the branches of SA "Mezdunarodnaya Kniga".

Contact information for IT (Russian):

Gosstandart, IT Editorial division
9, Leninsky Prospect
117049 Moscow
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Tel: 7-095-236-24 44
Fax: 7-095-237 60 32

Contact information for MT (English):

Plenum Publishing Corporation
233 Spring St.
New York, N.Y. 10013
Fax: 1-212-807 10 47

in the United Kingdom:

Plenum Publishing Corporation
88/90 Middlesex St.
London E17EZ

The basic principles and practice of flow measurement

Five-day course
15–19 May 1995
NEL, United Kingdom

Held annually for the past eighteen years, this course on flow measurement presents subject matter that is continually reviewed to keep it up to date. It is directed towards personnel involved in the design of plants requiring flow monitoring, or in the purchase, application and calibration of flow measuring equipment.

This course is not intended for flow measurement experts, but for the engineer seeking to know how to choose the flowmeter best adapted for his particular needs, and how to get the most out of it when in service.

Program

- Elements of pipe flow and properties of measuring instruments; differential pressure meters; ultrasonic meters; a meter manufacturer's view of the flow measurement scene; two-phase flow measurement.
- Calibration of meters with liquids and gases; velocity probes and integration techniques; construction and performance of positive displacement and turbine meters; vortex meters.
- Electromagnetic flowmeters; flowmeters secondary instrumentation; mass flow measurement.
- Assessment of uncertainties; national standards, transfer standards and traceability; pulsating flow measurement; troubleshooting and diagnosing faults.
- Site calibration methods; choosing the right flowmeter for the application; installation effects.

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OIML WELCOMES ITS NEW MEMBERS

Member State

Kazakhstan

CIML Members

Mr J. C. Bueno, Brazil
Mr J.F. Magana, France
Mr A. Nejjar, Morocco

Corresponding Members

Thailand
Uruguay

GENERAL BROCHURE SOON AVAILABLE

A new brochure presenting OIML and its structures and activities will be available as of May 1995.

Illustrating the important role of legal metrology in society, and featuring OIML's contribution to international efforts for harmonization in this area, this brochure will be useful to those concerned with metrology as well as those seeking to become familiar with this field of activity.

The OIML brochure may be obtained from BIML.

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CEN Distribution and Sales Unit, rue de Stassart, 36, 1050 Brussels, Belgium.

Standards for access to the European market
CEN Distribution and Sales Unit, rue de Stassart, 36, 1050 Brussels, Belgium.

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364 pp., ISBN 0 566 07512 1 (1994) Distribution and Sale unit: GOWER, Gower House, Croft Road, Aldershot, Hampshire GU11 3HR, United Kingdom.

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meetings OIML réunions

Spring 1995

To be fixed	TC 3/SC 2 Metrological supervision		PRAGUE OR BRNO

April 1995

19–21	TC 8/SC 5 Water meters		LONDON

May 1995

To be fixed	TC 13/WG 2 Audiometers		TO BE FIXED

June 1995

12–15	TC 3 and TC 4 Metrological control and Measurement standards and calibration and verification devices		PARIS/BIML

September 1995

11–12	TC 7/SC 5 Dimensional measuring instruments		PARIS
13–15	OIML seminar: "Weighing towards the year 2000"		PARIS
18–20	TC 9 and TC 9/SC 2 Instruments for measuring mass and density and Automatic weighing instruments		PARIS

October 1995

23–24	OIML Symposium on metrological activities in developing countries		BEIJING
25	Development Council meeting		BEIJING
25–27	30th CIML meeting		BEIJING
To be fixed	TC 8/SC 7 Gas metering		BRUSSELS

November 1995 *(provisional)*

	TC 17/SC 3 pH-metry		UK or PARIS/BIML

January or February 1996

To be fixed	TC 11 Instruments for measuring temperature		TO BE FIXED

info

OIML Seminar

WEIGHING TOWARDS THE YEAR 2000

13–15 Sept. 1995, Paris

At present, more than 100 participants are registered and additional registrations are welcome.

Mr S. Bennett, Member of the OIML Presidential Council and CIML Member for the United Kingdom, will chair the seminar. An editorial board of experts will assist him in selecting the papers that will be presented.

Main topics

- Nonautomatic weighing
- Automatic weighing
- Certification and mutual recognition
- Traceability problems
- Modular approach for testing
- Quality assurance systems applied by manufacturers
- Software interfaces and requirements for weighing instruments
- A new approach to type approvals

OIML Symposium

METROLOGICAL ACTIVITIES IN DEVELOPING COUNTRIES

23–24 Oct. 1995, Beijing

The Symposium is open to all countries, as well as regional and international institutions concerned with metrology, calibration, certification and other related activities. It will be followed by a meeting of the OIML Development Council and the 30th CIML meeting, all held at the Beijing International Convention Centre.

Lecture proposals have been received from Australia, P. R. of China, France, Germany, India, Malawi, Mauritius, Mongolia, Slovakia, United Kingdom, Vietnam, Yugoslavia, and regional metrological organisations in the Asia-Pacific and European regions.

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classified by subject and number

International Recommendations
International Documents
Other publications

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Principes de la surveillance métrologique

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Vocabulaire de métrologie légale (bilingue français-anglais)

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International vocabulary of basic and general terms in metrology (bilingual French-English)
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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

D 25 (being printed - *en cours de publication*)
Vortex meters used in measuring systems for fluids
Compteurs à vortex utilisés dans les ensembles de mesurage de fluides

D 26 (being printed - *en cours de publication*)
Glass delivery measures – Automatic pipettes
Mesures en verre à délivrer – Pipettes automatiques

Gas measurement
Mesurage des gaz(*)

R 6 (1989) 80 FRF
General provisions for gas volume meters
Dispositions générales pour les compteurs de volume de gaz

R 31 (1995) 80 FRF
Diaphragm gas meters
Compteurs de gaz à parois déformables

R 32 (1989) 60 FRF
Rotary piston gas meters and turbine gas meters
Compteurs de volume de gaz à pistons rotatifs et compteurs de volume de gaz à turbine

Pressure
Pressions(**)

R 23 (1975-*1973*) 60 FRF
Tyre pressure gauges for motor vehicles
Manomètres pour pneumatiques de véhicules automobiles

(*) See also "Liquid measurement" D 25 – *Voir aussi "Mesurage des liquides" D 25.*
(**) See also "Medical instruments" - *Voir aussi "Instruments médicaux".*

R 53 (1982) 60 FRF

Metrological characteristics of elastic sensing elements used for measurement of pressure. Determination methods

Caractéristiques métrologiques des éléments récepteurs élastiques utilisés pour le mesurage de la pression. Méthodes de leur détermination

R 97 (1990) 60 FRF

Barometers

Baromètres

R 101 (1991) 80 FRF

Indicating and recording pressure gauges, vacuum gauges and pressure vacuum gauges with elastic sensing elements (ordinary instruments)

Manomètres, vacuomètres et manovacuomètres indicateurs et enregistreurs à élément récepteur élastique (instruments usuels)

R 109 (1993) 60 FRF

Pressure gauges and vacuum gauges with elastic sensing elements (standard instruments)

Manomètres et vacuomètres à élément récepteur élastique (instruments étalons)

R 110 (1994) 80 FRF

Pressure balances

Manomètres à piston

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)

D 24 (being printed - *en cours de publication*)

Total radiation pyrometers

Pyromètres à radiation totale

P 16 (1991) 100 FRF

Guide to practical temperature measurements

(*) See also "Medical instruments" - *Voir aussi "Instruments médicaux"*.

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 (1994) 80 FRF

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 intégrateurs-moyenneurs

R 102 (1992) 50 FRF

Sound calibrators

Calibreurs acoustiques

Annex (being printed - *en cours de publication*)

Test procedures and test report format

Procédures d'essai et format du rapport d'essai

R 103 (1992) 60 FRF

Measuring instrumentation for human response to vibration

Appareillage de mesure pour la réponse des individus aux vibrations

R 104 (1993) 60 FRF

Pure-tone audiometers

Audiomètres à sons purs

Environment
Environnement

R 82 (1989) 80 FRF

Gas chromatographs for measuring pollution from pesticides and other toxic substances

Chromatographes en phase gazeuse pour la mesure des pollutions par pesticides et autres substances toxiques

R 83 (1990) 80 FRF

Gas chromatograph/mass spectrometer/data system for analysis of organic pollutants in water

Chromatographe en phase gazeuse équipé d'un spectromètre de masse et d'un système de traitement de données pour l'analyse des polluants organiques dans l'eau

R 99 (1991) 100 FRF

Instruments for measuring vehicle exhaust emissions

Instruments de mesure des gaz d'échappement des véhicules

R 100 (1991) 80 FRF

Atomic absorption spectrometers for measuring metal pollutants in water
Spectromètres d'absorption atomique pour la mesure des polluants métalliques dans l'eau

R 112 (1994) 80 FRF

High performance liquid chromatographs for measurement of pesticides and other toxic substances
Chromatographes en phase liquide de haute performance pour la mesure des pesticides et autres substances toxiques

R 113 (1994) 80 FRF

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

R 116 (being printed - *en cours de publication)*
Inductively coupled plasma atomic emission spectrometers for measurement of metal pollutants in water
Spectromètres à émission atomique de plasma couplés inductivement pour le mesurage 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 (being printed - *en cours de publication)*
Polarimetric saccharimeters
Saccharimètres polarimétriques

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

R 56 (1981) 50 FRF

Standard solutions reproducing the conductivity of electrolytes
Solutions-étalons reproduisant la conductivité des électrolytes

R 59 (1984) 80 FRF

Moisture meters for cereal grains and oilseeds
Humidimètres pour grains de céréales et graines oléagineuses

R 68 (1985) 50 FRF

Calibration method for conductivity cells
Méthode d'étalonnage des cellules de conductivité

R 69 (1985) 50 FRF

Glass capillary viscometers for the measurement of kinematic viscosity. Verification method
Viscosimètres à capillaire, en verre, pour la mesure de la viscosité cinématique. Méthode de vérification

R 70 (1985) 50 FRF

Determination of intrinsic and hysteresis errors of gas analysers
Détermination des erreurs de base et d'hystérésis des analyseurs de gaz

R 73 (1985) 50 FRF

Requirements concerning pure gases CO, CO_2, CH_4, H_2, O_2, N_2 and Ar intended for the preparation of reference gas mixtures
Prescriptions pour les gaz purs CO, CO_2, CH_4, H_2, O_2, N_2 et Ar destinés à la préparation des mélanges de gaz de référence

R 92 (1989) 60 FRF

Wood-moisture meters - Verification methods and equipment: general provisions
Humidimètres pour le bois - Méthodes et moyens de vérification: exigences générales

R 108 (1993) 60 FRF

Refractometers for the measurement of the sugar content of fruit juices
Réfractomètres pour la mesure de la teneur en sucre des jus de fruits

R 121 (being printed - *en cours de publication)*
The scale of relative humidity of air certified against satured salt solutions
Échelle d'humidité relative de l'air certifiée par rapport à des solutions saturées de sels

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

R 114 (1995) 80 FRF
Clinical electrical thermometers for continuous measurement
Thermomètres électriques médicaux pour mesurage en continu

R 115 (1995) 80 FRF
Clinical electrical thermometers with maximum device
Thermomètres électriques médicaux avec dispositif à maximum

R 122 (being printed - *en cours de publication)*
Equipement for speech audiometry
Appareils pour l'audiométrie vocale

D 21 (1990) 80 FRF
Secondary standard dosimetry laboratories for the calibration of dosimeters used in radiotherapy
Laboratoires secondaires d'étalonnage en dosimétrie pour l'étalonnage des dosimètres utilisés en radiothérapie

Testing of materials
Essais des matériaux

R 9 (1972–*1970)* 60 FRF
Verification and calibration of Brinell hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Brinell

R 10 (1974–*1970)* 60 FRF
Verification and calibration of Vickers hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Vickers

R 11 (1974–*1970)* 60 FRF
Verification and calibration of Rockwell B hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell B

R 12 (1974–*1970)* 60 FRF
Verification and calibration of Rockwell C hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell C

R 36 (1980–*1977)* 60 FRF
Verification of indenters for hardness testing machines
Vérification des pénétrateurs des machines d'essai de dureté

R 37 (1981–*1977)* 60 FRF
Verification of hardness testing machines (Brinell system)
Vérification des machines d'essai de dureté (système Brinell)

R 38 (1981–*1977)* 60 FRF
Verification of hardness testing machines (Vickers system)
Vérification des machines d'essai de dureté (système Vickers)

R 39 (1981–*1977)* 60 FRF
Verification of hardness testing machines (Rockwell systems B,F,T - C,A,N)
Vérification des machines d'essai de dureté (systèmes Rockwell B,F,T -C,A,N)

R 62 (1985) 80 FRF
Performance characteristics of metallic resistance strain gauges
Caractéristiques de performance des extensomètres métalliques à résistance

R 64 (1985) 50 FRF
General requirements for materials testing machines
Exigences générales pour les machines d'essai des matériaux

R 65 (1985) 60 FRF
Requirements for machines for tension and compression testing of materials
Exigences pour les machines d'essai des matériaux en traction et en compression

V 3 (1991) 80 FRF
Hardness testing dictionary (quadrilingual French-English-German-Russian)
Dictionnaire des essais de dureté (quadrilingue français-anglais-allemand-russe)

P 10 (1981) 50 FRF
The metrology of hardness scales - Bibliography

P 11 (1983) 100 FRF
Factors influencing hardness measurement

P 12 (1984) 100 FRF
Hardness test blocks and indenters

P 13 (1989) 100 FRF
Hardness standard equipment

P 14 (1991) 100 FRF
The unification of hardness measurement

Prepackaging
Préemballages

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

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

INTERNATIONAL RECOMMENDATIONS
RECOMMANDATIONS INTERNATIONALES

R 4 (1970–1972) 50 FRF
Volumetric flasks (one mark) in glass
Fioles jaugées à un trait en verre

R 6 (1989) 80 FRF
General provisions for gas volume meters
Dispositions générales pour les compteurs de volume de gaz

R 7 (1979–1978) 60 FRF
Clinical thermometers, mercury-in-glass with maximum device
Thermomètres médicaux à mercure, en verre, avec dispositif à maximum

R 9 (1972–1970) 60 FRF
Verification and calibration of Brinell hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Brinell

R 10 (1974–1970) 60 FRF
Verification and calibration of Vickers hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Vickers

R 11 (1974–1970) 60 FRF
Verification and calibration of Rockwell B hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell B

R 12 (1974–1970) 60 FRF
Verification and calibration of Rockwell C hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell C

R 14 (being printed - *en cours de publication*)
Polarimetric saccharimeters
Saccharimètres polarimétriques

R 15 (1974–1970) 80 FRF
Instruments for measuring the hectolitre mass of cereals
Instruments de mesure de la masse à l'hectolitre des céréales

R 16 (1973–1970) 50 FRF
Manometers for instruments for measuring blood pressure (sphygmomanometers)
Manomètres des instruments de mesure de la tension artérielle (sphygmomanomètres)

R 18 (1989) 60 FRF
Visual disappearing filament pyrometers
Pyromètres optiques à filament disparaissant

R 21 (1975–1973) 60 FRF
Taximeters
Taximètres

R 22 (1975–1973) 150 FRF
International alcoholometric tables (trilingual French-English-Spanish)
Tables alcoométriques internationales (trilingue français-anglais-espagnol)

R 23 (1975–1973) 60 FRF
Tyre pressure gauges for motor vehicles
Manomètres pour pneumatiques de véhicules automobiles

R 24 (1975–1973) 50 FRF
Standard one metre bar for verification officers
Mètre étalon rigide pour agents de vérification

R 26 (1978–1973) 50 FRF
Medical syringes
Seringues médicales

R 29 (1979–1973) 50 FRF
Capacity serving measures
Mesures de capacité de service

R 30 (1981) 60 FRF
End standards of length (gauge blocks)
Mesures de longueur à bouts plans (cales étalons)

R 31 (1995) 80 FRF
Diaphragm gas meters
Compteurs de gaz à parois déformables

R 32 (1989) 60 FRF
Rotary piston gas meters and turbine gas meters
Compteurs de volume de gaz à pistons rotatifs et compteurs de volume de gaz à turbine

R 33 (1979–1973) 50 FRF
Conventional value of the result of weighing in air
Valeur conventionnelle du résultat des pesées dans l'air

R 34 (1979–1974) 60 FRF
Accuracy classes of measuring instruments
Classes de précision des instruments de mesurage

R 35 (1985) 80 FRF
Material measures of length for general use
Mesures matérialisées de longueur pour usages généraux

R 36 (1980–1977) 60 FRF
Verification of indenters for hardness testing machines
Vérification des pénétrateurs des machines d'essai de dureté

R 37 (1981–1977) 60 FRF
Verification of hardness testing machines (Brinell system)
Vérification des machines d'essai de dureté (système Brinell)

R 38 (1981–1977) 60 FRF
Verification of hardness testing machines (Vickers system)
Vérification des machines d'essai de dureté (système Vickers)

R 39 (1981–1977) 60 FRF
Verification of hardness testing machines (Rockwell systems B,F,T-C,A,N)
Vérification des machines d'essai de dureté (systèmes Rockwell B,F,T-C,A,N)

R 40 (1981–1977) 60 FRF
Standard graduated pipettes for verification officers
Pipettes graduées étalons pour agents de vérification

R 41 (1981–1977) 60 FRF
Standard burettes for verification officers
Burettes étalons pour agents de vérification

R 42 (1981–1977) 50 FRF
Metal stamps for verification officers
Poinçons de métal pour agents de vérification

R 43 (1981–1977) 60 FRF
Standard graduated glass flasks for verification officers
Fioles étalons graduées en verre pour agents de vérification

R 44 (1985) 50 FRF
Alcoholometers and alcohol hydrometers and thermometers for use in alcoholometry
Alcoomètres et aréomètres pour alcool et thermomètres utilisés en alcoométrie

R 45 (1980–1977) 50 FRF
Casks and barrels
Tonneaux et futailles

R 46 (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

R 47 (1979–1978) 60 FRF
Standard weights for testing of high capacity weighing machines
Poids étalons pour le contrôle des instruments de pesage de portée élevée

R 48 (1980–1978) 50 FRF
Tungsten ribbon lamps for calibration of optical pyrometers
Lampes à ruban de tungstène pour l'étalonnage des pyromètres optiques

R 49 (in revision - *en cours de révision*)
Water meters intended for the metering of cold water
Compteurs d'eau destinés au mesurage de l'eau froide

R 50 (1994) 100 FRF
Continuous totalizing automatic weighing instruments (belt weighers)
Instruments de pesage totalisateurs continus à fonctionnement automatique (peseuses sur bande)

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 53 (1982) 60 FRF
Metrological characteristics of elastic sensing elements used for measurement of pressure. Determination methods
Caractéristiques métrologiques des éléments récepteurs élastiques utilisés pour le mesurage de la pression. Méthodes de leur détermination

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

R 55 (1981) 50 FRF
Speedometers, mechanical odometers and chronotachographs for motor vehicles. Metrological regulations
Compteurs de vitesse, compteurs mécaniques de distance et chronotachygraphes des véhicules automobiles. Réglementation métrologique

R 56 (1981) 50 FRF
Standard solutions reproducing the conductivity of electrolytes
Solutions-étalons reproduisant la conductivité des électrolytes

R 58 (1984) 50 FRF
Sound level meters
Sonomètres

R 59 (1984) 80 FRF
Moisture meters for cereal grains and oilseeds
Humidimètres pour grains de céréales et graines oléagineuses

R 60 (1991) 80 FRF
Metrological regulation for load cells
Réglementation métrologique des cellules de pesée

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

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

R 62 (1985) 80 FRF
Performance characteristics of metallic resistance strain gauges
Caractéristiques de performance des extensomètres métalliques à résistance

R 63 (1994) 50 FRF
Petroleum measurement tables
Tables de mesure du pétrole

R 64 (1985) 50 FRF
General requirements for materials testing machines
Exigences générales pour les machines d'essai des matériaux

R 65 (1985) 60 FRF
Requirements for machines for tension and compression testing of materials
Exigences pour les machines d'essai des matériaux en traction et en compression

R 66 (1985) 60 FRF
Length measuring instruments
Instruments mesureurs de longueurs

R 68 (1985) 50 FRF
Calibration method for conductivity cells
Méthode d'étalonnage des cellules de conductivité

R 69 (1985) 50 FRF
Glass capillary viscometers for the measurement of kinematic viscosity. Verification method
Viscosimètres à capillaire, en verre, pour la mesure de la viscosité cinématique. Méthode de vérification

R 70 (1985) 50 FRF
Determination of intrinsic and hysteresis errors of gas analysers
Détermination des erreurs de base et d'hystérésis des analyseurs de gaz

R 71 (1985) 80 FRF
Fixed storage tanks. General requirements
Réservoirs de stockage fixes. Prescriptions générales

R 72 (1985) 60 FRF
Hot water meters
Compteurs d'eau destinés au mesurage de l'eau chaude

R 73 (1985) 50 FRF
Requirements concerning pure gases CO, CO_2, CH_4, H_2, O_2, N_2 and Ar intended for the preparation of reference gas mixtures
Prescriptions pour les gaz purs CO, CO_2, CH_4, H_2, O_2, N_2 et Ar destinés à la préparation des mélanges de gaz de référence

R 74 (1993) 80 FRF
Electronic weighing instruments
Instruments de pesage électroniques

R 75 (1988) 60 FRF
Heat meters
Compteurs d'énergie thermique

R 76-1 (1992) 300 FRF
Nonautomatic weighing instruments. Part 1: Metrological and technical requirements - Tests
Instruments de pesage à fonctionnement non automatique. Partie 1: Exigences métrologiques et techniques - Essais

Amendment No. 1 (1994) free / *gratuit*

R 76-2 (1993) 200 FRF
Nonautomatic weighing instruments. Part 2: Pattern evaluation report
Instruments de pesage à fonctionnement non automatique. Partie 2: Rapport d'essai de modèle

Amendment No. 1 (1995) free / *gratuit*

R 78 (1989) 50 FRF
Westergren tubes for measurement of erythrocyte sedimentation rate
Pipettes Westergren pour la mesure de la vitesse de sédimentation des hématies

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

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 82 (1989) 80 FRF
Gas chromatographs for measuring pollution from pesticides and other toxic substances
Chromatographes en phase gazeuse pour la mesure des pollutions par pesticides et autres substances toxiques

R 83 (1990) 80 FRF
Gas chromatograph/mass spectrometer/data system for analysis of organic pollutants in water
Chromatographe en phase gazeuse équipé d'un spectromètre de masse et d'un système de traitement de données pour l'analyse des polluants organiques dans l'eau

R 84 (1989) 60 FRF
Resistance-thermometer sensors made of platinum, copper or nickel (for industrial and commercial use)
Capteurs à résistance thermométrique de platine, de cuivre ou de nickel (à usages techniques et commerciaux)

R 85 (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 87 (1989) 50 FRF
Net content in packages
Contenu net des préemballages

R 88 (1989) 50 FRF
Integrating-averaging sound level meters
Sonomètres intégrateurs-moyenneurs

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 91 (1990) 60 FRF
Radar equipment for the measurement of the speed of vehicles
Cinémomètres radar pour la mesure de la vitesse des véhicules

R 92 (1989) 60 FRF
Wood-moisture meters - Verification methods and equipment: general provisions
Humidimètres pour le bois - Méthodes et moyens de vérification: exigences générales

R 93 (1990) 60 FRF
Focimeters
Frontofocomètres

R 95 (1990) 60 FRF
Ships' tanks - General requirements
Bateaux-citernes - Prescriptions générales

R 96 (1990) 50 FRF
Measuring container bottles
Bouteilles récipients-mesures

R 97 (1990) 60 FRF
Barometers
Baromètres

R 98 (1991) 60 FRF
High-precision line measures of length
Mesures matérialisées de longueur à traits de haute précision

R 99 (1991) 100 FRF
Instruments for measuring vehicle exhaust emissions
Instruments de mesure des gaz d'échappement des véhicules

R 100 (1991) 80 FRF
Atomic absorption spectrometers for measuring metal pollutants in water
Spectromètres d'absorption atomique pour la mesure des polluants métalliques dans l'eau

R 101 (1991) 80 FRF
Indicating and recording pressure gauges, vacuum gauges and pressure vacuum gauges with elastic sensing elements (ordinary instruments)
Manomètres, vacuomètres et manovacuomètres indicateurs et enregistreurs à élément récepteur élastique (instruments usuels)

R 102 (1992) 50 FRF
Sound calibrators
Calibreurs acoustiques

Annex (being printed - *en cours de publication*)
Test procedures and test report format
Procédures d'essai et format du rapport d'essai

R 103 (1992) 60 FRF
Measuring instrumentation for human response to vibration
Appareillage de mesure pour la réponse des individus aux vibrations

R 104 (1993) 60 FRF
Pure-tone audiometers
Audiomètres à sons purs

R 105 (1993) 100 FRF
Direct mass flow measuring systems for quantities of liquids
Ensembles de mesurage massiques directs de quantités de liquides

Annex (being printed - *en cours de publication*)
Test report format
Format du rapport d'essai

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

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

Annex (being printed - *en cours de publication*)
Test procedures and test report format
Procédures d'essai et format du rapport d'essai

R 108 (1993) 60 FRF
Refractometers for the measurement of the sugar content of fruit juices
Réfractomètres pour la mesure de la teneur en sucre des jus de fruits

R 109 (1993) 60 FRF
Pressure gauges and vacuum gauges with elastic sensing elements (standard instruments)
Manomètres et vacuomètres à élément récepteur élastique (instruments étalons)

R 110 (1994) 80 FRF
Pressure balances
Manomètres à piston

R 111 (1994) 80 FRF
Weights of classes E_1, E_2, F_1, F_2, M_1, M_2, M_3
Poids des classes E_1, E_2, F_1, F_2, M_1, M_2, M_3

R 112 (1994) 80 FRF
High performance liquid chromatographs for measurement of pesticides and other toxic substances
Chromatographes en phase liquide de haute performance pour la mesure des pesticides et autres substances toxiques

R 113 (1994) 80 FRF
Portable gas chromatographs for field measurements of hazardous chemical pollutants
Chromatographes en phase gazeuse portatifs pour la mesure sur site des polluants chimiques dangereux

R 114 (1995) 80 FRF
Clinical electrical thermometers for continuous measurement
Thermomètres électriques médicaux pour mesurage en continu

R 115 (1995) 80 FRF
Clinical electrical thermometers with maximum device
Thermomètres électriques médicaux avec dispositif à maximum

R 116 (being printed - *en cours de publication*)
Inductively coupled plasma atomic emission spectrometers for measurement of metal pollutants in water
Spectromètres à émission atomique de plasma couplés inductivement pour le mesurage des polluants métalliques dans l'eau

R 117 (being printed - *en cours de publication*)
Measuring assemblies for liquids other than water
Ensembles de mesurage de liquides autres que l'eau

R 118 (being printed - *en cours de publication*)
Testing procedures for pattern examination of fuel dispensers for motor vehicles
Procédures d'évaluation des modèles de distributeurs de carburant pour véhicules à moteur

R 119 (being printed - *en cours de publication*)
Pipe provers for testing of measuring systems for liquids other than water
Tubes étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

R 120 (being printed - *en cours de publication*)
Characteristics of standard capacity measures and test methods for measuring systems for liquids other than water
Caractéristiques des mesures de capacité étalons et méthodes d'essai des ensembles de mesurage de liquides autres que l'eau

R 121 (being printed - *en cours de publication*)
The scale of relative humidity of air certified against saturated salt solutions
Échelle d'humidité relative de l'air certifiée par rapport à des solutions saturées de sels

R 122 (being printed - *en cours de publication*)
Equipment for speech audiometry
Appareils pour l'audiométrie vocale

INTERNATIONAL DOCUMENTS
DOCUMENTS INTERNATIONAUX

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 4 (1981) 50 FRF
Installation and storage conditions for cold water meters
Conditions d'installation et de stockage des compteurs d'eau froide

D 5 (1982) 60 FRF
Principles for the establishment of hierarchy schemes for measuring instruments
Principes pour l'établissement des schémas de hiérarchie des instruments de mesure

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

D 7 (1984) 80 FRF
The evaluation of flow standards and facilities used for testing water meters
Evaluation des étalons de débitmétrie et des dispositifs utilisés pour l'essai des compteurs d'eau

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

D 9 (1984) 60 FRF
Principles of metrological supervision
Principes de la surveillance métrologique

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

D 11 (1994) 80 FRF
General requirements for electronic measuring instruments
Exigences générales pour les instruments de mesure électroniques

D 12 (1986) 50 FRF
Fields of use of measuring instruments subject to verification
Domaines d'utilisation des instruments de mesure assujettis à la vérification

D 13 (1986) 50 FRF
Guidelines for bi- or multilateral arrangements on the recognition of: test results - pattern approvals - verifications
Conseils pour les arrangements bi- ou multilatéraux de reconnaissance des: résultats d'essais - approbations de modèles - vérifications

D 14 (1989) 60 FRF
Training of legal metrology personnel - Qualification - Training 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 17 (1987) 50 FRF
Hierarchy scheme for instruments measuring the viscosity of liquids
Schéma de hiérarchie des instruments de mesure de la viscosité des liquides

D 18 (1987) 50 FRF
General principles of the use of certified reference materials in measurements
Principes généraux d'utilisation des matériaux de référence certifiés dans les mesurages

D 19 (1988) 80 FRF
Pattern evaluation and pattern approval
Essai de modèle et approbation de modèle

D 20 (1988) 80 FRF
Initial and subsequent verification of measuring instruments and processes
Vérifications primitive et ultérieure des instruments et processus de mesure

D 21 (1990) 80 FRF
Secondary standard dosimetry laboratories for the calibration of dosimeters used in radiotherapy
Laboratoires secondaires d'étalonnage en dosimétrie pour l'étalonnage des dosimètres utilisés en radiothérapie

D 22 (1991) 80 FRF
Guide to portable instruments for assessing airborne pollutants arising from hazardous wastes
Guide sur les instruments portatifs pour l'évaluation des polluants contenus dans l'air en provenance des sites de décharge de déchets dangereux

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

D 24 (being printed - *en cours de publication*)
Total radiation pyrometers
Pyromètres à radiation totale

D 25 (being printed - *en cours de publication*)
Vortex meters used in measuring systems for fluids
Compteurs à vortex utilisés dans les ensembles de mesurage de fluides

D 26 (being printed - *en cours de publication*)
Glass delivery measures - Automatic pipettes
Mesures en verre à délivrer - Pipettes automatiques

VOCABULARIES
VOCABULAIRES

V 1 (1978) 100 FRF
Vocabulary of legal metrology (bilingual French-English)
Vocabulaire de métrologie légale (bilingue français-anglais)

V 2 (1993) 200 FRF
International vocabulary of basic and general terms in metrology (bilingual French-English)
Vocabulaire international des termes fondamentaux et généraux de métrologie (bilingue français-anglais)

V 3 (1991) 80 FRF
Hardness testing dictionary (quadrilingual French-English-German-Russian)
Dictionnaire des essais de dureté (quadrilingue français-anglais-allemand-russe)

OTHER PUBLICATIONS
AUTRES PUBLICATIONS

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

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

P 3 (being printed - *en cours de publication*)
Metrology in OIML Member States and Corresponding Member Countries
Métrologie dans les Etats Membres et Pays Membres Correspondants de l'OIML

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

P 5 (1992) 100 FRF
Mobile equipment for the verification of road weighbridges (bilingual French- English)
Equipement mobile pour la vérification des ponts-bascules routiers (bilingue français-anglais)

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

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

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

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

P 10 (1981) 50 FRF
The metrology of hardness scales - Bibliography

P 11 (1983) 100 FRF
Factors influencing hardness measurement

P 12 (1984) 100 FRF
Hardness test blocks and indenters

P 13 (1989) 100 FRF
Hardness standard equipment

P 14 (1991) 100 FRF
The unification of hardness measurement

P 15 (1989) 100 FRF
Guide to calibration

P 16 (1991) 100 FRF
Guide to practical temperature measurements

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

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

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