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A NEW CHEMICAL METHOD IMPROVES MEASUREMENT TECHNIQUE FOR AIR ANALYSIS

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Photo by Philippe Sion The Image Bank

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Editorial

B. Athané
Director, Bureau International de Métrologie Légale

METROLOGY is one of the very first technical activities that has involved international cooperation. The *Convention du Mètre* was signed in 1875; the first *Conférence Internationale de Métrologie Pratique et Légale* took place in 1937 before the establishment of OIML in 1955.

Since then, an important regional cooperation has developed. At the European level, EUROMET (scientific metrology), WELMEC (legal metrology) and WECC (accreditation of calibration laboratories), were established by the metrology services of Western European countries already cooperating within the European Community (now referred to as the European Union) and the European Free Trade Association. In Central and Eastern Europe, COOMET develops a similar cooperation (information on recent meetings given on pp. 40–41). In other regions of the world, certain organizations are making their own efforts to develop regional cooperation.

Regional cooperation may be, for its international counterpart, an obstacle or an incentive.

It is an obstacle when regional bodies try to develop their own regional rules independently of international consensus; when countries that have not been able to make their views prevail at international level try to be more successful at regional level; when international documents are significantly modified to meet the so-called *specificities* of a region, thus creating new technical barriers to trade; when countries of a given region constitute a blocking minority that prevents any progress at international level and finally, when regional bodies, considering that consensus is obtained easier at regional level, speed up their work to then oblige the rest of the world to adopt their views.

On the contrary, regional cooperation is an excellent incentive for worldwide cooperation when international documents are implemented at regional level without significant changes and with a transparency which permits any country to export products that meet international provisions; when countries facing a specific problem at regional level accept to work with other countries to solve the problem at international level; and when difficulties that are encountered in regional implementation of a given international document are publicized, thus serving as a basis for improving that document.

In the field of legal metrology, cooperation between OIML and regional bodies, especially WELMEC and COOMET, is excellent. Some problems may still exist with certain other regional bodies with which OIML has perhaps not developed sufficient relations.

It is in fact the clear policy of OIML to develop effective liaisons with all regional bodies – governmental or not – that have a role to play in the harmonization of legal metrology requirements and testing procedures; the new OIML work structures and program have therefore been widely distributed not only to international bodies but also to all potentially interested regional bodies with a view to associating them in the development and implementation of OIML International Recommendations.

B. Athané

Air quality measurement

DETERMINATION OF NO_x IN GAS EMISSIONS AND IN REFERENCE CALIBRATION GASES BY NEDA-PHOTOMETRY

CLEAN AIR MEASUREMENT Interlaken 28 Sept - 1 Oct 1992

S. YANAGISAWA
Prof. Emeritus, Keio University, Japan
Convener of ISO/TC 146/SC 1/WG 3

The aim of ISO TC 146 (Air quality) is to establish an internationally "traceable" method of determining the concentrations of oxides of nitrogen in gaseous emissions.

TRACEABILITY is assured by two methods: one is by the use of a calibration gas contained in a cylinder and made up gravitationally from the component gases; the other is by means of standard solutions, produced gravimetrically from pure reagents.

The first method, using a binary mixture of NO and N_2, or NO_2 and N_2, is convenient for the calibration of automated analysers. However, its life is limited by regulation to six months because the inner surface of the cylinder reacts with the component gas.

The second method has the advantage that no gas cylinder is required; all that is needed is a chemical balance to weigh out the standard pure reagent. The results obtained by each of the above methods are in good agreement.

For the determination method, there are two types of ions: NO_2 and NO_3, that give rise to colour development with certain dyes, measurable by their absorption of light in a photometer. The coloration of azo-dye with NO_2 is an order of magnitude more sensitive than that of any dye with NO_3.

When fifteen types of sensitive azo-dyes were tested with the NO_2 ion, NEDA (naphtlethylenediamine), with its clear red colour, was found to be the most sensitive.

The results were reported in Japan by the *Steel Industry Foundation for the Advancement of Environmental Protection Technology* (Mr Yoshito Matsuda and Mr Keihei Ueno, Kyushu University, July 1953).

As regards the time required for the determination, the oxidation of NO and NO_2 to NO_3 with O_2 in the gas phase takes more than 16 hours, so that the results are not generally available until the next day. This slow oxidation of NO_x entails high labour costs.

By contrast, O_3 quickly oxidizes NO and NO_2 to N_2O_5 in the gas phase, and it becomes NO_3^- in solution. The preparation of O_3 by electrostatic discharge in O_2 has the disadvantage that, even where the O_2 contains few ppm of N_2, some oxides of nitrogen are produced, giving results of determination that err on the high side.

The near proximity of the boiling points of O_2 and N_2 make difficult the preparation of O_2 without the presence of some ppm of N_2, the chemical elimination of which is not easy. However, the preparation of O_3 by discharge in O_2 produces N_2O_5, which can be eliminated as $NaNO_3$, by bubbling the gas through an alkaline solution of NaOH. These procedures require complicated techniques, as reported ten years ago by myself and colleagues in the Keio University journal.

However, oxidation with O_3 not only converts NO into N_2O_5, but it also simultaneously converts NH_3 into N_2O_5, giving the determination a falsely high result.

NH_3 is sometimes contained in gas emissions, especially where large quantities are added to a furnace in order to give protection from corrosion by SO_2, or in order to perform catalytic denitration. The O_3 method of determination shows artificially increased NO_x, proportional to the added quantities of NH_3. Thus it has been found that oxidation by O_3 often gives results that are too high.

These defects in the existing methods were the reasons for the development of the new method that is described here.

1. Principle of the new method

The main characteristic of the proposed new method is the use of the Pourbaix diagram of potential-pH of the system N_2-H_2O. By this relation, NO and NO_2 convert in solution to the single ion NO_2, by shaking with a NaOH-alkaline H_2O_2 solution containing the Cu^{++} ion.

H_2O_2 acts as a reducing agent in the solution. The NO_2 ions thus produced are stable, and NO_3 ions are not produced in the absorbed solutions, as has been shown by ion-chromatography. However, H_2O_2 in the sample solution disturbs the colour development with NEDA, and to prevent that the H_2O_2 is decomposed by the addition of a catalase enzyme (for 0.15 % H_2O_2), or by maintaining the temperature of the solution at 80 °C for 30 minutes, with Cu^{++} ions as catalyst (for 0.6 % H_2O_2).

NO_2 is determined by measuring the absorbance of the coloured solution produced by reaction with sulfanilamide and NEDA at a wavelength of 545 nm, using a photometer. The mass concentration of NO_2 is obtained by means of a calibration graph, which can be prepared by using a pure $NaNO_2$ standard solution.

2. List of reagents

Absorption solution

- For gaseous emissions: NaOH 1.2N, H_2O_2 0.6 %, HCOONa 0.0002 %
- For reference calibration gas: NaOH 0.2N, H_2O_2 0.15 %
- $CuSO_4$ solution: $4 \cdot 10^{-4}$ M
- Sulfanilamide/HCl solution: Sulfanilamide 0.5 %, HCl 20 %
- NEDA (Naphtlethylenediamine) solution: 0.1 %
- $NaNO_2$ solution: NO_2^- 250 mg/l
- Diluted $NaNO_2$ solution: NO_2^- 10 mg/l, and 20 mg/l
- HCl solution: 3N
- Catalase(1) solution: 0.14 %, for use only with reference calibration gas

3. Apparatus required

The apparatus required includes:

- 1 000 ml calibrated sampling flask having a three-way tap (Fig 1)
- Photoelectric spectrophotometer or photoelectric photometer

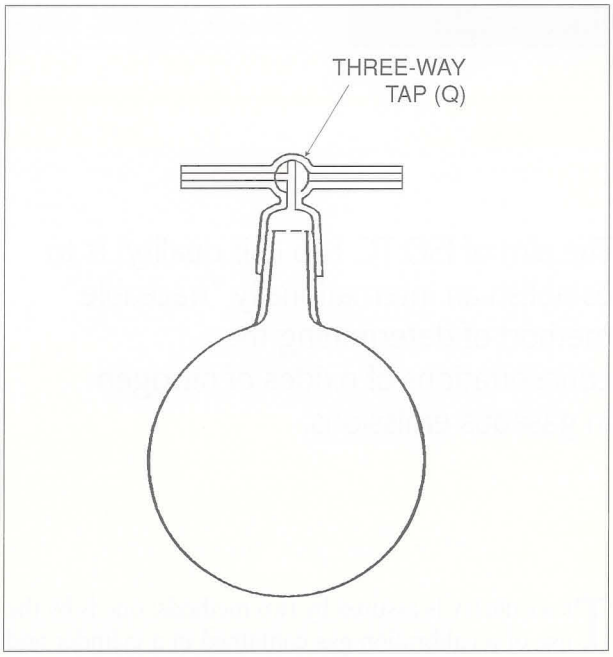


Fig. 1 Gas sampling flask (E)
(Approximately 1 000 ml capacity)

4. Preparation of gas samples and solutions

The Reference Calibration Gas (RCG) is easily and quickly prepared (20 min). Because it does not contain CO_2, SO_2 and hydrocarbons, and does not require much H_2O_2, the remaining H_2O_2 can easily be decomposed by adding a small quantity of catalase enzyme.

Actual gaseous emissions are, however, complicated, with their multiple components and higher temperatures. These samples need more abundant quantities of H_2O_2 to eliminate co-existing, interfering components;

(1) This enzyme is commercially available, for example from Sigma Chemical Co. Ltd., St. Louis, USA.

the decomposition of the relatively large quantities of remaining H_2O_2 requires heating for 30 minutes at 80 °C, instead of the addition of catalase enzyme.

Reference Calibration Gas (RCG)

A sampling flask, manometer and vacuum pump are required. The sampling flask is connected to the vacuum pump, the manometer and the RCG cylinder via the three-way valve and silicone-rubber tubing.

The three-way valve is positioned so that the sampling flask is open to the vacuum pump, with the manometer closed off. The flask is evacuated. The three-way valve is turned gently to close off the manometer to the vacuum pump and open it to the flask, to read the pressure (P_0); at the same time the ambient temperature (T_0) is measured and recorded.

The three-way valve is turned to open the sampling flask briefly to the RCG cylinder, and then returned to the position in which the flask is open to the manometer, to measure the pressure (P_1). The ambient temperature is read and recorded a second time (T_1).

The three-way valve is positioned to close the sampling flask, and the silicone-rubber tubes are removed. The absorption solution (50 ml) and copper-sulphate solution (5 ml) are injected into the flask by means of the syringe (Figs. 2 and 2'). Without further delay the flask is shaken vigorously and intermittently for one minute net.

The sample solution just prepared is transferred from the sampling flask to a 100 ml volumetric flask. The sampling flask is rinsed several times with water which is added to the sample solution in the volumetric flask.

Gaseous emissions

The sampling apparatus is shown diagrammatically in Fig. 3. It is constructed of materials that are inert to the components of the gas; the sampling tube is heated to a temperature that is not less than 120 °C above that of the dewpoint for HNO_x.

1.0 ml of water is introduced into the dried sampling flask by means of a pipette.

The sampling flask is installed in the sampling apparatus by means of silicone-rubber connector tubes. The three-way valve is positioned to close the sampling flask to the manometer and open it to the vacuum pump. The flask is evacuated.

When the water in the flask begins to boil, the flask is gently closed to the vacuum pump (by manipulation of the three-way valve) and made open to the manometer. The first pressure (P_0) is read and recorded, and the ambient temperature (T_0) is simultaneously read and noted.

By means of the three-way valve the sampling flask is opened to introduce a sample of emission gas for about 10 seconds, then closed. The sample is allowed to cool for five minutes; then the second pressure (P_0) and second ambient temperature (T_0) are measured and recorded.

The sample flask is then closed by means of the three-way valve, the silicone-rubber connections are removed (thus disconnecting the flask from the rest of the apparatus), and immediately, with the least possible delay, the mixture of absorption solution (50 ml) and copper sulphate solution (5 ml) is injected into it by means of the syringe (Fig. 2). Without further delay the flask is shaken vigorously and intermittently for one minute net.

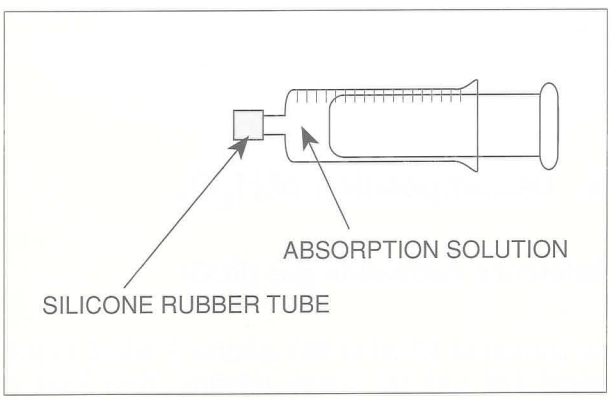


Fig. 2 Syringe for introducing the absorption solution.

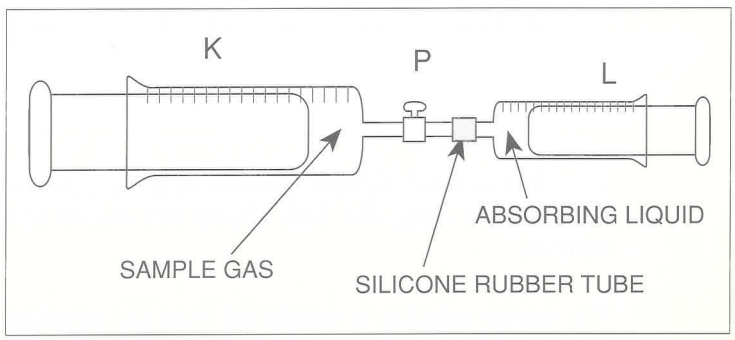
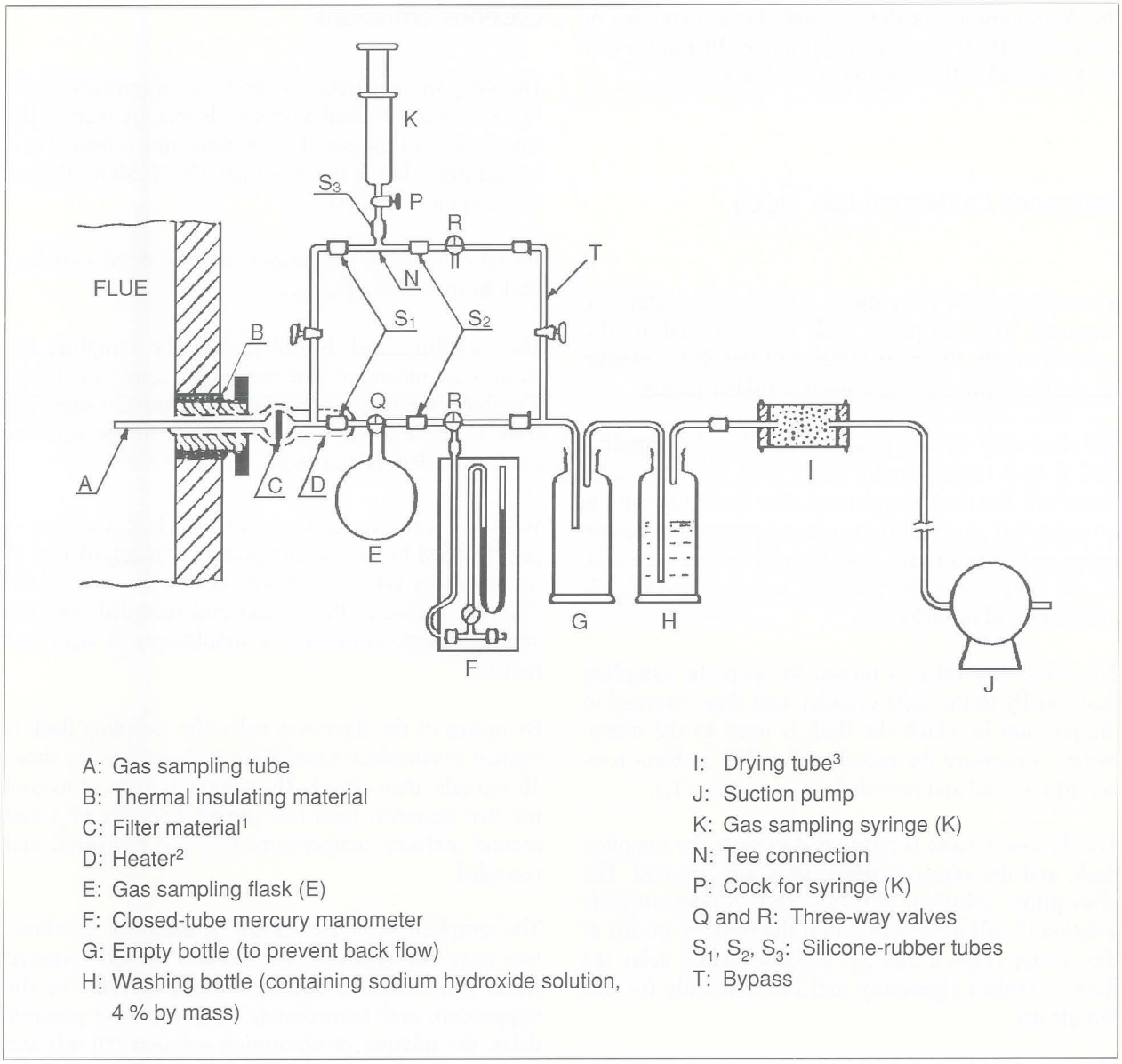


Fig. 2' Sampling syringe. The sample gas may be taken by means of a sampling syringe instead of the sampling flask. The capacity of the sampling syringe is 200 ml or 500 ml.



A: Gas sampling tube
B: Thermal insulating material
C: Filter material[1]
D: Heater[2]
E: Gas sampling flask (E)
F: Closed-tube mercury manometer
G: Empty bottle (to prevent back flow)
H: Washing bottle (containing sodium hydroxide solution, 4 % by mass)
I: Drying tube[3]
J: Suction pump
K: Gas sampling syringe (K)
N: Tee connection
P: Cock for syringe (K)
Q and R: Three-way valves
S_1, S_2, S_3: Silicone-rubber tubes
T: Bypass

Fig. 3 Gas sampling apparatus.

Notes: 1. The filter must be of an inert material, such as silica fibre, which does not react with the components constituting the gaseous emissions; cellulose filter paper or glass fibre containing alkali, which react with nitrogen dioxide, should never be used.

2. The tube should be as short as possible, and, to prevent the condensation of moisture, heated to a temperature exceeding the acid dew point of the sample gas by at least 120 °C.

3. The dessicant should be of granular silica gel or calcium chloride.

The time interval between introducing the gas and beginning to shake the flask should not exceed five minutes.

The sample solution is transferred from the sampling flask to a 250 ml volumetric flask. The sampling flask is rinsed a few times with water, which is added to the solution in the volumetric flask.

5. Decomposition of H_2O_2

Reference calibration gas (RCG)

An amount of 3.5 ml of HCl solution is added to and mixed well with the sample solution. Then 5 ml of catalase solution is added and mixed by shaking.

Gaseous emissions

The flask, with its lid removed, is placed in a bath at 80 °C for 30 minutes. It is then removed, shaken and cooled under running water.

6. Preparing the sample solution for analysis

Water is added to the solution in the 100 ml volumetric flask to bring its meniscus to the mark. This solution is subsequently used for analysis.

7. Determination procedure

Sets of calibration solutions

A set of calibration solutions is prepared with ion concentrations of NO_2 of respectively 0.1, 0.2, 0.3 and 0.4 µg/ml, by pipetting respectively 10, 20, 30 and 40 ml of the diluted (NO_2 10 mg/l) $NaNO_2$ solution into each of four 100 ml flasks.

A second set of calibration solutions containing respectively 0.2, 0.4, 0.6 and 0.8 µg/ml NO_2^- is prepared in the same way using the second diluted $NaNO_2$ solution (NO_2^- 20 mg/l).

Preparation of the blank solution

50 ml of the absorption solution (see list of reagents above) and 5 ml of the copper sulphate solution are pipetted into a 100 ml volumetric flask. The procedure for the decomposition of H_2O_2 is carried out, and the solution is made up to 100 ml with water.

20.0 ml of this solution is pipetted into a 100 ml flask, together with 10 ml of the sulfanilamide/hydrochloric acid solution (see list of reagents above), 5 ml of the NEDA solution and sufficient water to make the solution up to the mark.

The solution is allowed to stand for 15 minutes at a temperature in the range 15 °C to 30 °C, and can then be used as a blank solution in the photometer.

Measurement of absorbance

A solution is prepared from the sample solution by the same procedure as that for the blank solution: 20.0 ml(2) of sample solution, together with 10 ml of the sulfanilamide/hydrochloric acid solution and 5 ml of the NEDA solution are made up to 100 ml with water in a volumetric flask, and allowed to stand for 15 minutes at a temperature in the range 15 °C to 30 °C.

The absorbance is measured by means of the photometer, using the blank solution as a blank.

Calibration graphs

The absorbances of the calibration solutions are determined by the same procedures as the sample solutions, as above.

A graph of absorbance as a function of NO_2 concentration in the samples is plotted (Fig. 4).

The slope of the straight line in the graph is given by equation 1:

$$\frac{\Delta A}{\Delta c} = \frac{1}{f}$$

where:

A is the absorbance,
c is the mass concentration of NO_2 in µg/ml,
f is the calibration factor in µg/ml, related to a 1 cm optical cell.

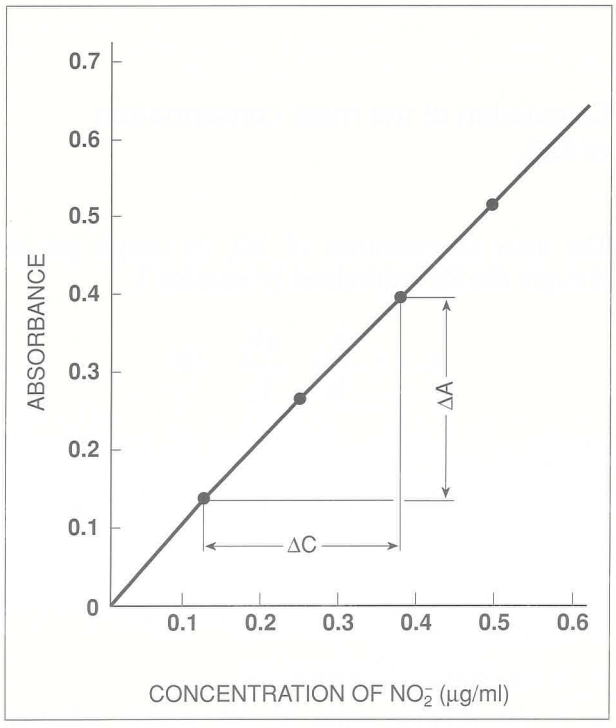


Fig. 4 An example of calibration curve for nitrogen oxides.

(2) If the mass concentration of NO_2 in the solution exceeds 1.2 µg/ml, the calibration curve ceases to be linear. Such a solution should be diluted with water to bring its concentration below that critical level.

Calculation of amount of sample gas taken

The amount of sample gas taken, referred to the standard atmospheric condition (0 °C, 101.3 kPa) is calculated by means of equation 2:

$$V_s = V_a \cdot \frac{273}{101.3} \left(\frac{P_1 - P_{w1}}{273 + T_1} - \frac{P_0 - P_{w0}}{273 + T_0} \right)$$

where:

V_s is the amount of sample gas taken, in ml;

V_a is capacity of flask, less the volume of water added (if any): in ml;

P_o is the pressure in the flask before gas sampling, in kPa;

P_1 is the pressure in the flask after gas sampling, in kPa;

T_o is the temperature of the flask before gas sampling, in °C;

T_1 is the temperature of the flask after gas sampling, in °C;

P_{wo} is the saturate water vapour pressure at T_o, in kPa;

P_{w1} is the saturate water vapour pressure at T_1, in kPa.

Calculation of the mass concentration of NO_x

The mass concentration of NO_x in sample gas as nitrogen dioxide is calculated by equation 3:

$$C = f \frac{A}{b} \cdot \frac{nV_t}{V_s} \cdot 10^3$$

where:

C is the mass concentration of NO_x in the sample gas, in mg/m^3;

f is the calibration factor in µg/ml solution;

A is the absorbance;

b is the optical cell length in cm;

n is the dilution ratio of the sample solution: (250/50 = 5)

V_t is the volume of the total sample solution in ml: (100);

V_s is the volume of the sample gas, at standard atmospheric conditions, in ml.

Influence quantities

- Sulphur dioxide

SO_2 reacts with NO and NO_2 in the gas phase:

$SO_2 + NO_x + H_2O \rightarrow N_2O + H_2SO_4$

These reactions proceed rapidly in the gas sampling tube (> 120 °C) and occur even in the ambient atmosphere (Figs. J and L). Therefore every method of determination is influenced by this reaction taking place while the sample gas is introduced into a sampling flask, the pressure (P_1) and temperature (T_1) are read, the flask is removed from apparatus and is shaken with absorption solution.

However, its effect on the results is slight and not very significant, as the rate of the reaction is rather slow.

- Cupric ions (Cu^{++})

Cupric ions (Cu^{++}) reduce slightly the formation of the azo-dye. Thus the amount of Cu^{++} added, including that in the blank solution, should never vary.

- Other constituents of gaseous emissions

Small quantities of HCl, SO_3, CO_2, $N_2O{\cdot}NH_4$, aldehydes and phenols do not affect the results.

Performance characteristics

Lower detection limit

The lower detection limit is expected to be a NO_x concentration of 0.2 mg/m^3 when using a 5 cm optical cell.

Repeatability

The repeatability of the method is expected to be about 1 % at concentration levels of NO_x of about 200 mg/m^3 to about 2 000 mg/m^3.

Reproducibility

The reproducibility of this method is expected to be about 3 % at mass concentration levels of NO_x of about 200 mg/m^3 to about 2 000 mg/m^3. ■

ANNEX

Reaction dynamics

The oxidation-reduction potential-pH diagram (Pourbaix diagram) of N_2-H_2O system is shown in Fig. A.

The following reactions occur readily at pH 13.

$NO + HO_2^- + e^- = NO_2^- + OH^-$

$NO_2 + HO_2^- = NO_2^- + H^+ + e^-$

H_2O_2 seems to act as a reducing agent in the following equation of reaction:

$NO_3^- + HO_2^- = NO_2^- + OH^- + O_2$

$\Delta G° = + 26430 + 15610 - 8250 - 37595 - 0$ (cal. mol^{-1})

$\Delta G° = - 3805$ (cal. mol^{-1})

However, experiments have shown that the reaction $NO_2^- \rightleftarrows NO_3^-$ in a strongly alkaline (pH > 13) H_2O_2 solution does not proceed in both directions.

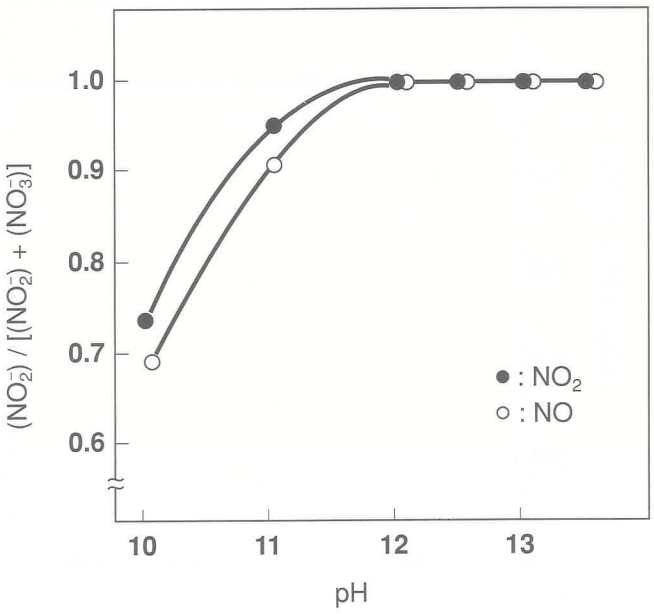


Fig. B Dependence of conversion of NO or NO_2 to NO_2^- on pH. Absorption solution: 0.15 % H_2O_2.

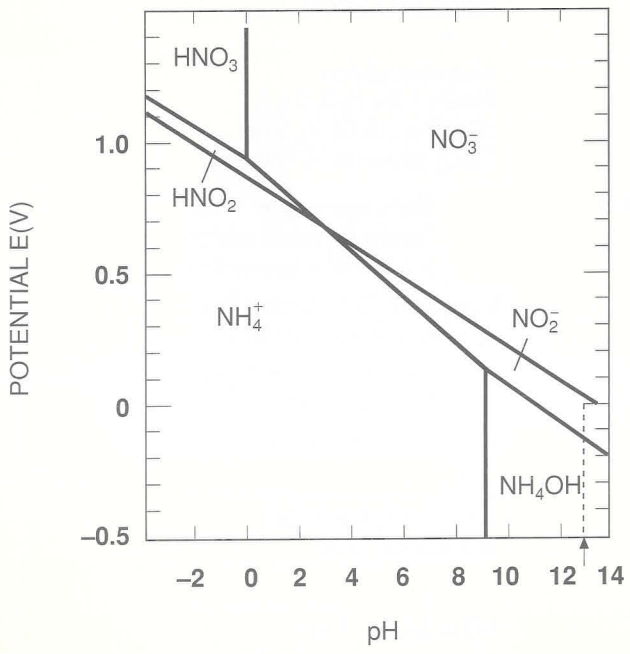


Fig. A Potential-pH (Pourbaix) – Diagram of the System N_2-H_2O.

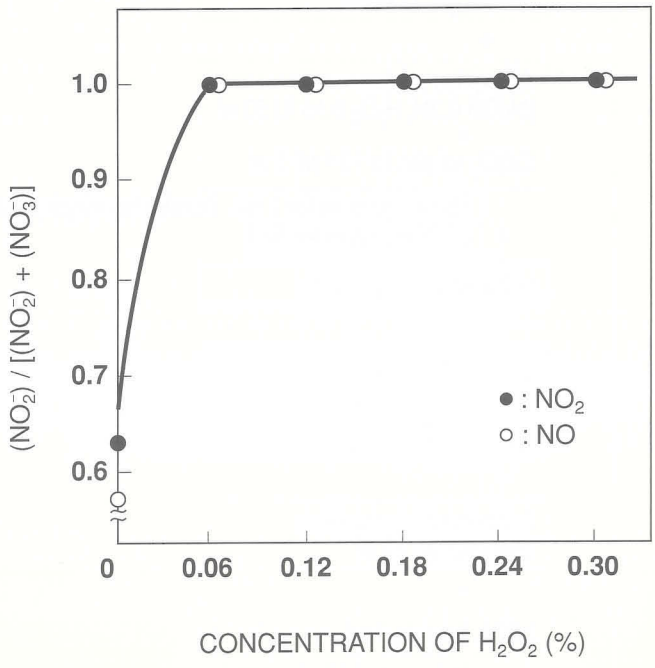


Fig. C Conversion of NO or NO_2 to NO_2^- versus concentration of H_2O_2. Absorption solution: pH 13.0

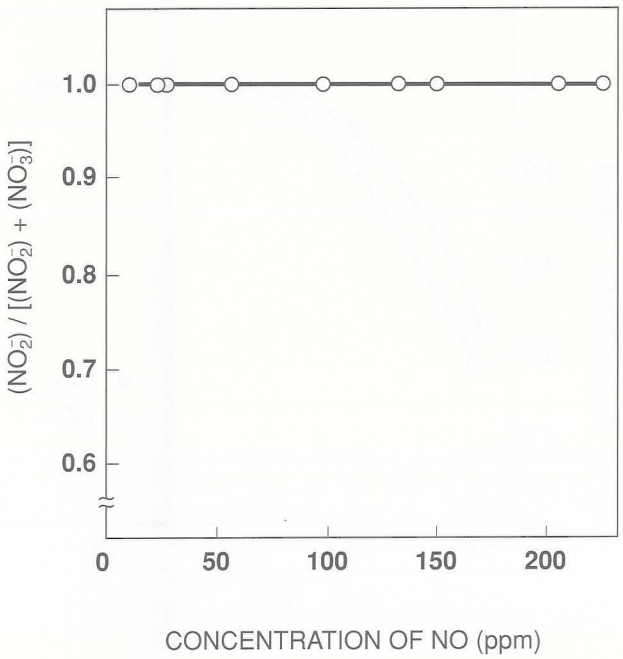


Fig. D Dependence of conversion of NO to NO_2^- on concentration of NO gas.

NO converts completely into NO_2^- under the chosen conditions. NO_3 is never produced (confirmed by ion-chromatography).

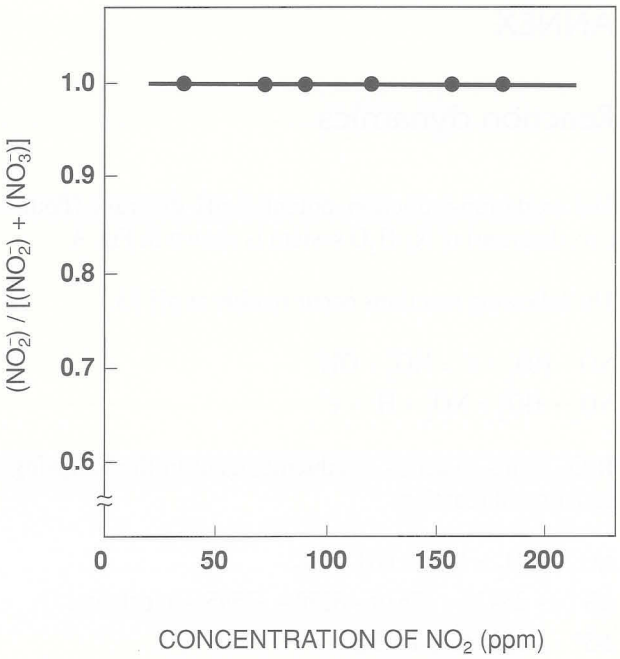


Fig. E Dependence of conversion of NO_2 to NO_2^- on concentration of NO_2 gas.

NO_2 converts completely into NO_2^- under the chosen conditions. NO_3 is never produced (confirmed by ion-chromatography).

SUMMARY OF DETERMINATION PROCEDURES

Determination procedure scheme

Reference Calibration Gas

Sample gas 1 000 ml

+

Absorption solution, (NaOH 0.2N, H_2O_2 0.15 %) 50 ml
+
$CuSO_4$ solution ($4 \cdot 10^{-4}$ M) 5 ml

+ Shake vigorously for 1 min. Transfer the sample solution to a 100 ml volumetric flask

HCl Solution (3N), 3.5 ml

+

Catalase Solution, 5 ml

Make up to 100 ml in the volumetric flask

Take 20.0 ml into a 100 ml volumetric flask

+

Sulfanilamide hydrochloric acid solution, 10 ml

+

NEDA Solution, 1 ml

Make up to 100 ml
Stand for 15 min.

Measure absorbance at 545 nm

Exhaust Gas

Sample gas 1 000 ml

+

Absorption solution, (NaOH 1.2N, H_2O_2 0.6 %, HCOONa 0.0005 %), 50 ml
$CuSO_4$ solution ($4 \cdot 10^{-4}$ M) 5 ml

Shake vigorously for 1 min.
Transfer the sample solution to a 100 ml volumetric flask

Decompose H_2O_2 by dipping flask in a water bath, 80 °C for 30 min.

Cool flask with running water.
Make up to 100 ml.

Take 20.0 ml into a 100 ml volumetric flask

+

Sulfanilamide hydrochloric acid solution, 10 ml

+

NEDA Solution, 1 ml

Make up to 100 ml
Stand for 15 min.

Measure absorbance at 545 nm

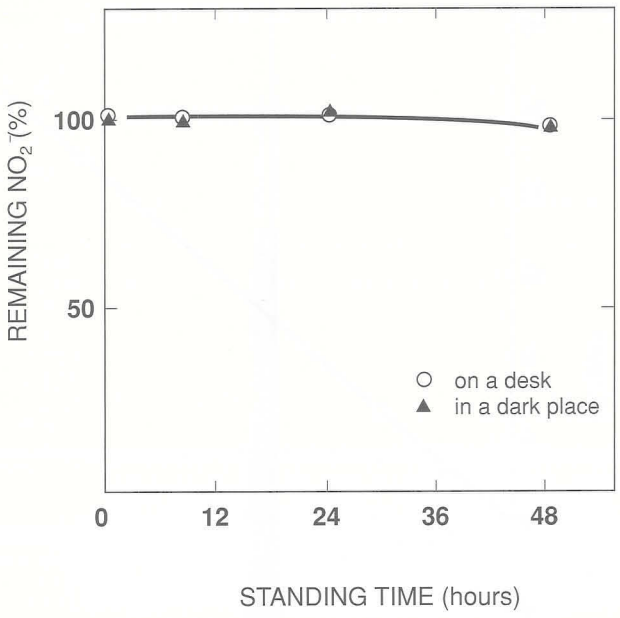


Fig. F Effect of standing time after the absorption of NO.

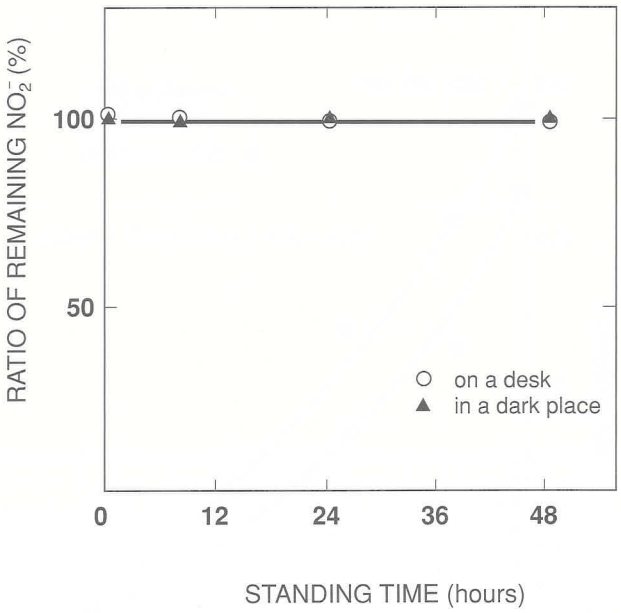


Fig. G Effect of standing time after the decomposition of H_2O_2.

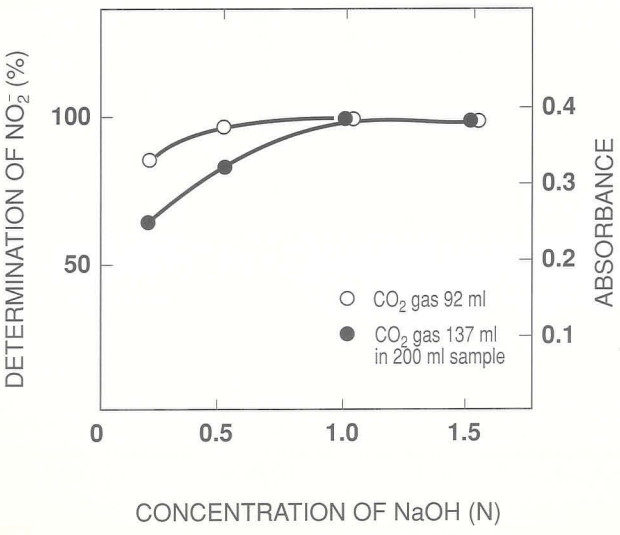


Fig. H Effect of CO_2 gas on the determination of NO_2^- at various concentrations of NaOH solution.

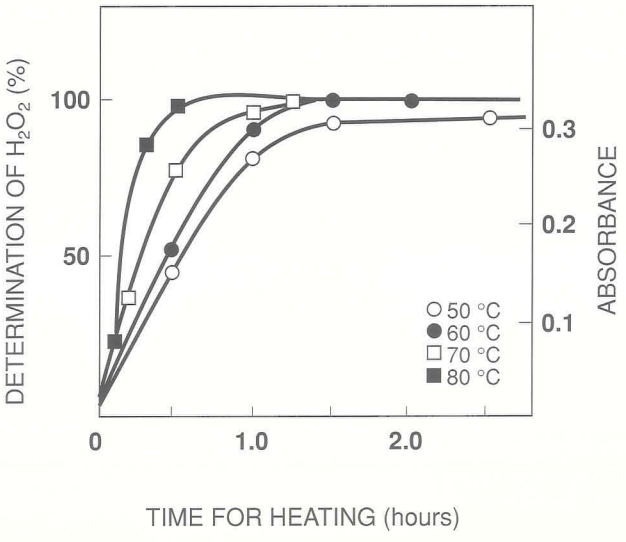


Fig. I Effect of temperature on the decomposition of H_2O_2. Absorption solution: 2.0 % H_2O_2.

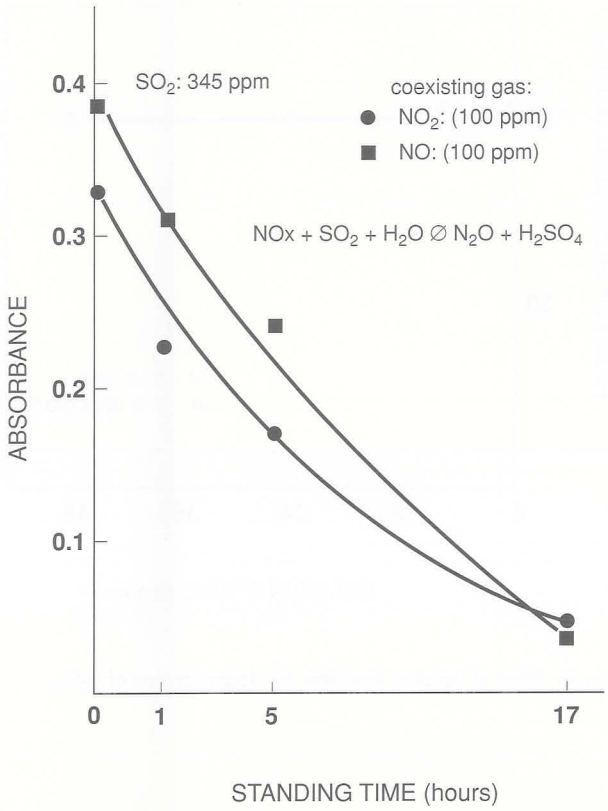


Fig. J Reaction of NO_x with SO_2 in gas phase.

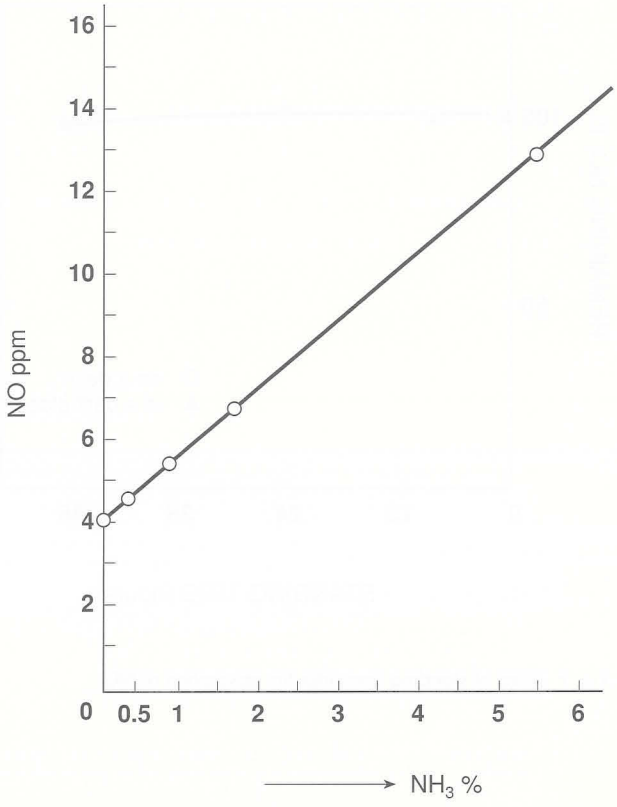


Fig. K Oxidation of NH_3 into N_2O_5 by O_3.

If O_3 is used for the oxidation of NO_x to NO_3^-, the presence of NH_3 in the emission gas sample gives a falsely high result. And if NH_3 is used to protect a boiler from corrosion by SO_2 and for the reduction of NO_x emissions, the remaining NH_3 causes a falsely high reading of NO_x by the addition of O_3.

Traceability for weights

HOW TO ACHIEVE MORE ACCURACY AT HIGH CAPACITIES – DESIGN PRINCIPLES OF A 50 kg MASS COMPARATOR

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In industrial and legal metrology, the accuracy required for heavy load weighing instruments has become tremendously high. Thus, for the testing and calibration of high capacity scales, more accurate masses are necessary. For the calibration of those, high precision mass standards are also needed.

THE trend towards more accuracy in this range of application raises the expectations of users for better 50 kg mass standards as mass scale representatives which are traceable to the national 1 kg mass prototype. With the summation of good 50 kg standards, calibrating 1 t masses will be much easier than before. Moreover, basing the connection on 50 kg masses is more convenient than referring to summations of smaller masses with the values of 10 kg or 20 kg.

Electronic mass comparators have been designed to create the metric mass scale for multiples of the 1 kg primary standard up to 50 kg. The function principle of the mass comparators that are presented in this article is the electromagnetic force compensation.

Together with self-centering load receptor supports and fully automatic load alternation, these mass comparators easily meet the error class E_1 requirements for mass values up to 50 kg.

The mass comparators presented in this article are considered as a part of a system which comprises the comparators, their control unit, an air density parameter sensoring system for buoyancy correction, and a master PC.

Traceability chain

A 50 kg mass standard of OIML class E_2 has a maximum permissible error (MPE) of 75 mg. The extrapolation of the table of errors to 500 kg and 1 t standards would lead to following MPE's:

500 kg (E_2) MPE = 750 mg
1 t (E_2) MPE = 1 500 mg

Mass standards complying with this accuracy are necessary to control class F_1 working standards to be used for heavy scale calibration purposes.

The traceability of these class E_2 reference standards must be guaranteed through a "traceability chain" which ends at the national 1 kg standard mass prototype kept at the national institutes of metrology and standardization in different countries.

This traceability chain comprises the following main points:

1 kg National prototype
↓
1 kg Main standard at a local laboratory
↓
10 kg
↓
50 kg
↓
500 kg, 1 t

For example, a 500 kg standard may be controlled and certified by 10 x 50 kg mass standards for which the mass values are known by uncertainties in accordance with class E_1.

Appropriate uncertainties

The 50 kg mass standards of class E_1 are relatively expensive and therefore, keeping a permanent quantity of 10 x 50 kg standards of class E_1 quality should be avoided. Instead, it is recommended to use 50 kg standards of class F_1 quality, but to determine these mass values with class E_1 uncertainties with the use of an appropriate mass comparator. On a short-term basis, these standards aligned with class E_1 can be fully utilized since their mass values will remain stable during the time needed for the calibration of the 500 kg standard.

A similar consideration applies to the 1 t mass standards. The requirement of creating the metric mass scale from 1 kg up to 50 kg in OIML error class E_1 has been the basis for the design of a line of electronic mass comparators to ensure uncertainties not exceeding:

$$U_w = \frac{1}{3} \text{ MPE } (E_1) = \frac{1}{3} 25 \text{ mg} < 7.5 \text{ mg}$$

Based on a 3 σ level in accordance with a statistical confidence level of 99.72 %, the maximum permissible standard deviation for the 50 kg mass comparator is specified by:

SD = 2.5 mg

This standard deviation can easily be achieved with a mass comparator as presented in Fig. 1.

This mass comparator comprises a complete system enabling fully automatic mass comparison procedures. The operating metrologist can therefore avoid any human influence on the ambient conditions. All standards such as 20 kg, 30 kg and 50 kg can be handled on this comparator. The best relative accuracy achievable is $2 \cdot 10^{-8}$.

The basis for obtaining 50 kg standards are 10 kg standards which must be determined with an uncertainty that is also in accordance with class E_1 or better. For this purpose, another fully automatic mass comparator system with maximum capacity of 10 kg by either 0.1 mg or, if desired, 0.01 mg readability is needed (Fig. 2). All procedures carried out on this comparator are based on a couple of high precision 1 kg mass standards which may be determined by another fully automatic 1 kg mass comparator of a readability of 1 µg.

Courtesy of Sartorius AG

Fig. 1 Fully automatic mass comparator system with linear, 2-position load alternator.

Max load capacity: 55 kg
Readability: 2 mg
Repeatability*: > 5 mg

* Max standard deviation of the second difference of a single mass comparison determined from a weighing series at $\Delta T \leq 0.5$ K within 10...30 °C.

Fully automized systems

There are important reasons for mass comparisons of this chain from 1 kg to 50 kg to be performed on fully automized systems.

First, the air buoyancy on the objects which is proportional to the air density will vary whenever the density varies. Small air density variations already have considerable influence on the resulting force being introduced into the weighing cell. That is why small changes of temperature and air pressure have a big impact on the standard deviation.

Second, if there is a steady drift of ambient conditions causing a zero drift effect through buoyancy, the method of double substitution would compensate the drift effect as long as the time elapsing from one

measurement to the next is uniform during the complete mass comparison process. This condition can be best satisfied by fully automized mass comparator systems.

Features of high accuracy mass comparators

- The weighing cell operates according to the principle of electromagnetic force compensation. This means that small changes of the gravitation force that are introduced into the weighing cell (for example, if you switch from one mass reference standard to the other test piece) result in an electromagnetic force dependent system via the lever system of the cell.

This creates a change of the counter force in order to keep the whole system in equilibrium. Thus, a force compensation has been realized. The changes in the counter force result from changes of the electric current through the coil of the electromagnet. The "analog signal" is to be evaluated and transferred to the indicating device of the mass comparator.

- A high degree of self-centering technology is necessary to ensure that the resultant force entering the weighing cell is not subject to any sort of parallel side shifts. This is realized by centering under pan supports which react principally like spherical pendulums. Instead of being suspended, however, the supports are located underneath the carrier plates.

In order to avoid swinging effects, the centering supports need particular damping devices. The individual technical solution depends on the range of nominal mass values.

- A good load alternating technology is the third basic feature for designing highly accurate mass comparators since the transfer from one object to the other must be carried smoothly and uniformly. ■

Courtesy of Sartorius AG

Fig. 2 Fully automatic mass comparator for testing mass standards up to 10 kg.

Les étalons d'ordre 1 du kilogramme en Roumanie

LA COMPARAISON DE L'ÉTALON NATIONAL P_2 A SES TÉMOINS

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Institut National de Métrologie, Roumanie

The National Institute of Metrology (INM) in Romania received the updated value of its National prototype P_2 from BIPM in 1993; an intercomparison has therefore been made between the National prototype and the four duplicate standards of order 1: B_8 composed of white bronze (1891), I_1 and I_2 composed of stainless steel (1964), and Ni_{81} composed of nicral (1978). This article describes the reference weights, the equipment used for the comparisons, the calculations and results, and the associated uncertainties.

L'INSTITUT National de Métrologie (INM) a entrepris, à la fin de l'année 1993, la comparaison périodique du prototype national du kilogramme en platine iridié (n° 2) à ses témoins qui représentent en Roumanie des étalons d'ordre 1. Les comparaisons se sont déroulées sur une période de 3 mois (octobre-décembre).

Les quatre étalons d'ordre 1 sont: l'étalon B_8 en bronze blanc (qui a été attribué à la Roumanie en 1891), les étalons I_1 et I_2 en acier inoxydable (qui ont été réalisés en 1964 à l'Institut National de Métrologie de Bucarest) et l'étalon Ni_{81} en nicral (attribué en 1978 et réalisé par la firme Prolabo-France).

Ces quatre étalons d'ordre 1 (B_8, I_1, I_2 et Ni_{81}) ont été comparés (Fig. 1) en utilisant comme référence l'étalon national P_2 (Fig. 2) qui a reçu en 1993 sa valeur actualisée par le BIPM.

Description des étalons

Le kilogramme étalon B_8

Le kilogramme étalon B_8 est massif et il a la forme d' un cylindre droit; ses composants principaux sont les suivants: Cu: 54,82 %; Ni: 43,7 %; Co: 1,44 %.

Cet étalon a été construit au BIPM et porte le symbole "B" qui représente l'initiale du matériau (bronze); ses dimensions sont les suivantes:

Diamètre d = 53,1 mm
Hauteur h = 51,8 mm

Sur la face cylindrique, le chiffre "8" est marqué par dépolissage; pour les comparaisons, cet étalon a été identifié par le symbole "B_8".

La masse du kilogramme B_8 a été établie pour la première fois en 1903-1904 au BIPM. Ses valeurs caractéristiques de masse volumique et volume à 0 °C sont:

Masse volumique: 8 902 kg·m^{-3}
Volume: 112,335 cm^3.

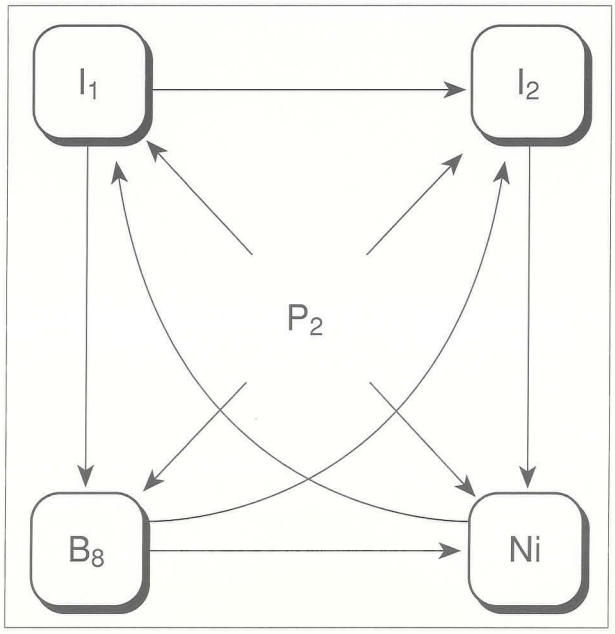

Fig. 1 Comparaison de quatre étalons d'ordre 1 à l'étalon national P_2.

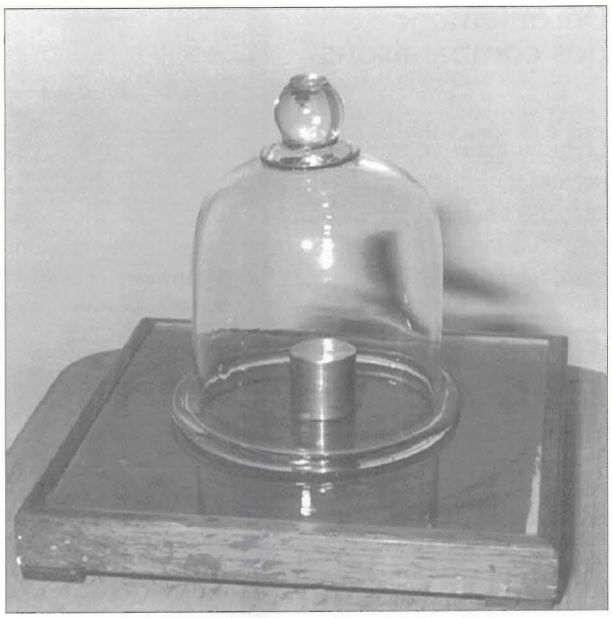

Fig. 2 Prototype national du kilogramme (P_2) de l'Institut National de Métrologie en Roumanie.

Les kilogrammes étalons I_1 et I_2

Les kilogrammes étalons I_1 et I_2 sont massifs, ont la forme d'un cylindre droit et sont constitués d'acier inoxydable comportant un pourcentage de 13,8 % de Cr. Au cours des comparaisons, ils ont été symbolisés par I_1 et I_2 (les chiffres "1" et "2" ont été poiçonnés afin de pouvoir les distinguer). Ils ont été construits en 1964 à l'Institut National de Métrologie de Bucarest; leurs dimensions respectives sont les suivantes:

Kilogramme I_1: d = 53,82 mm
h = 56,82 mm

Kilogramme I_2: d = 53,38 mm
h = 56,69 mm

Les valeurs de leurs volume et masse volumique ont été déterminées hydrostatiquement à l'INM en 1965-1966:

Pour I_1: Masse volumique à 0 °C: 7 730 kg·m^{-3}
Volume à 0 °C: 129,356 cm^3

Pour I_2: Masse volumique à 0 °C: 7 730 kg·m^{-3}
Volume à 0 °C: 129,362 cm^3

Kilogramme en nicral Ni_{81}

Le kilogramme en nicral Ni_{81} a la forme d'un cylindre de diamètre approximativement égal à la hauteur; ses arêtes sont légèrement arrondies. Il est constitué d'une seule pièce de matériau sans cavité intérieure; il a été ajusté par usure progressive. La masse volumique du kilogramme a été déterminée au BIPM par des pesées hydrostatiques:

Masse volumique à 0 °C: 7 836 kg·m^{-3}
Volume à 0 °C: 127,6161 cm^3

Equipement du laboratoire

Balance

La balance (Fig. 3) utilisée pour les comparaisons des kilogrammes est munie d'un mécanisme qui permet d'effectuer des pesées suivant la méthode de Gauss, sans ouvrir la cage et sans s'approcher de la balance (distance minimale de l'opérateur par rapport à la balance pendant les comparaisons: 4 m).

Les principes généraux et, plus particulièrement la conception du mécanisme de transposition des étalons, sont dus au Professeur M.F. Arzberger qui a dessiné les plans du mécanisme; la construction a été confiée à M.

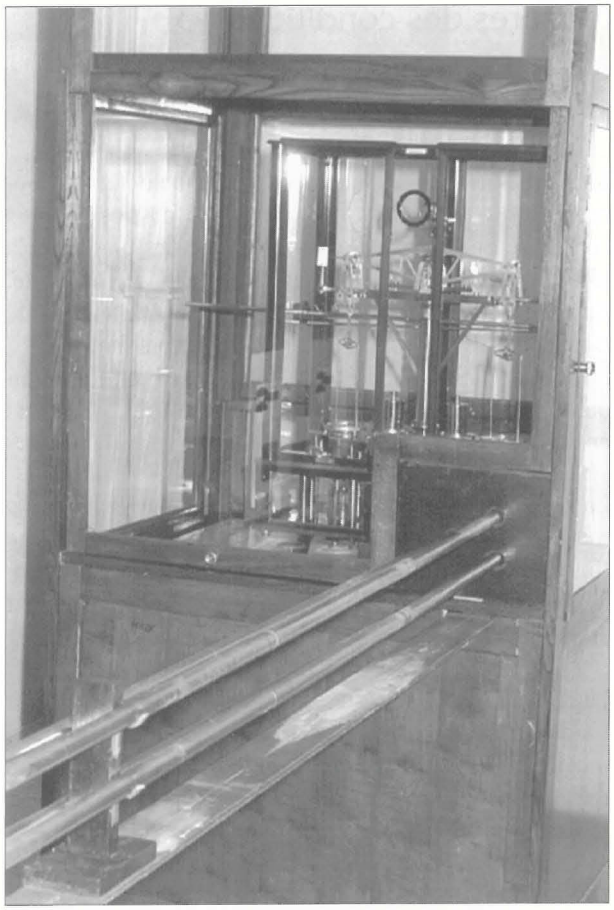

Fig. 3 Balance utilisée pour les comparaisons des kilogrammes et capable d'effectuer des pesées suivant la méthode Gauss.

A. Rueprecht et H. Schorss à Vienne (la balance proprement dite a été construite par M. A. Rueprecht et le mécanisme de transposition, le bâti et la cage ont été réalisés par H. Schorss). La lecture de la balance se fait au moyen d'une lunette dirigée sur un prisme réflecteur qui est fixé au montant; un miroir horizontal, fixé au fléau de la balance au dessus du prisme complète le dispositif de lecture.

Disques supports

Au cours des comparaisons, les étalons se trouvent sur des disques supports (symbolisés par T et T* dans les ouvrages) placés eux-mêmes sur les plateaux de la balance afin d'éviter que les kilogrammes ne soient en contact direct avec le mécanisme transporteur. Les disques supports sont construits en alliage de nickel; de forme circulaire, ils comportent des arêtes légèrement arrondies.

Mesures des conditions ambiantes

La température a été mesurée à l'aide de deux thermomètres (de fabrication allemande) disposés dans l'enceinte de la balance, au voisinage des plateaux, la lecture pouvant s'effectuer sans ouverture de l'enceinte. Ces deux thermomètres (échelon 0,1 °C – intervalle de mesure 10 °C–40 °C) ont été préalablement étalonnés à l'INM. La mesure de la température a été effectuée au début et à la fin de chaque série de mesures. On a pris ensuite la moyenne des deux résultats.

La pression a été mesurée à l'aide d'un baromètre à mercure (également de fabrication allemande – firme Ilmenau) disposé au voisinage de la balance. Ce baromètre (valeur d'échelon: 0,1 torr) a été préalablement étalonné à l'INM.

La mesure de la pression a été effectuée au début et à la fin de chaque série de mesures, pour calculer ensuite la moyenne des résultats. La température de la chambre a été relevée à l'aide d'un thermomètre complémentaire fixé à mi-hauteur sur le baromètre.

L' humidité de l'air a été déterminée à l'aide d'un hygromètre, construit et préalablement étalonné à l'INM [étendue de mesure: (45–75) %].

Déroulement des comparaisons

Le mécanisme de transposition qui équipe les balances permet d'éliminer, pour chaque pesée individuelle, le zéro de l'échelle de la balance (par la méthode de Gauss). Etant donné que ces instruments ne permettent pas d'opérer une variation de charge sans que l'observateur s'approche de la balance, l'opérateur doit déterminer la sensibilité de la balance (ou la valeur d'échelle en milligrammes) par la combinaison de deux pesées différentes, respectivement avant et après le changement de charge nécessaire.

Une comparaison complète se décompose en quatre pesées partielles entre lesquelles l'opérateur doit s'approcher de la balance, soit pour disposer une surcharge supplémentaire sur un des plateaux (pour déterminer la sensibilité), soit pour transposer les kilogrammes sur les plateaux auxiliaires montés sur la colonne.

Après les opérations préliminaires (lavage, centrage et équilibrage des poids), on laisse reposer la balance pendant 24 heures, en général. Le jour de la comparaison, l'observateur ne doit en aucun cas s'approcher de l'instrument, la lecture étant faite à l'aide de la lunette. La pesée est commencée en observant quatre élongations consécutives (l_1, l_2, l_3, l_4) de la balance; la formule utilisée pour calculer le déséquilibre est la suivante:

$$L = 1/8\ (l_1 + 3\ l_2 + 3\ l_3 + l_4)$$

Les essais se sont déroulés conformément au schéma suivant en quatre étapes:

- La première étape a comporté neuf pesées individuelles:

1	Ni + T+ EC	I_1 + T*
2	I_1 + T*	Ni + T + EC
:	:	:
:	:	:
:	:	:
9	Ni + T + EC	I_1+ T*

où: Ni et I_1 sont les étalons à comparer;

T et T* sont les disques supports décrits précédemment;

EC est la masse utilisée pour obtenir l'équilibre.

- Dans la deuxième étape on a déterminé la valeur de l'échelle de la balance:

1	Ni + T + EC + ET	I_1 + T*
2	I_1 + T*	Ni + T + EC + ET
:	:	:
:	:	:
9	Ni + T + EC + ET	I_1 + T*

où ET est la surcharge pour déterminer la valeur de l'échelle.

- La troisième étape est identique à la première en intervertissant les étalons:

1	I_1 + T	Ni + T* + EC
2	Ni + T* + EC	I_1 + T
:	:	:
:	:	:
9	I_1 + T	Ni + T* + EC

- Dans la quatrième étape, on a déterminé à nouveau la valeur de l'échelle de la balance:

1	I_1 + T + ET	Ni + T* + EC
2	Ni + T* + EC	I_1 + T + ET
:	:	:
:	:	:
9	I_1 + T + ET	Ni + T* + EC

Le calcul de la pesée est commencé à partir de ces quatres pesées partielles (1, 2, 3, 4) en tenant compte de la correction de réduction au vide. La masse volumique de l'air humide a été calculée d'après les données du Rapport BIPM-81/8 "Formule pour la détermination de la masse volumique de l'air humide" [3].

Le calcul de la masse est basé sur la méthode de la comparaison en série fermée du kilogramme en platine avec les quatre autres étalons de 1 kg, en utilisant un système de dix équations de condition (symbolisées par "x_1" à "x_{10}"):

1	$P_2 - Ni = x_1$
2	$P_2 - B_8 = x_2$
3	$P_2 - I_2 = x_3$
4	$P_2 - I_1 = x_4$
5	$Ni - B_8 = x_5$
6	$Ni - I_2 = x_6$
7	$Ni - I_1 = x_7$
8	$B_8 - I_2 = x_8$
9	$B_8 - I_1 = x_9$
10	$I_2 - I_1 = x_{10}$

Ce schéma a été effectué encore une fois; si l'on désigne par "a_i" (i = 1 à 10) les valeurs des différences mesurées, on obtient:

$x_1 = a_1$
$x_2 = a_2$
$x_3 = a_3$
$x_4 = a_4$
$x_1 - x_2 = a_5$
$x_1 - x_3 = a_6$
$x_1 - x_4 = a_7$
$x_2 - x_3 = a_8$
$x_2 - x_4 = a_9$
$x_3 - x_4 = a_{10}$

Par la résolution de ces équations on obtient (en utilisant la méthode des moindres carrés) la valeur de la masse de ces étalons ainsi que l'écart-type expérimental pour chaque détermination.

Etude des incertitudes

Incertitudes relatives aux paramètres intervenant dans la détermination des valeurs de Ni, B_8, I_1 et I_2

- Toutes les incertitudes données dans cette section sont exprimées comme incertitudes-type (niveau 1 σ).
- Etalon national P_2: le BIPM a donné l'incertitude suivante sur la masse étalon de référence P_2 (conformément au certificat n° 6): 0,0023 mg.
- Masses utilisées comme surcharges: l'incertitude due aux surcharges (qui sont constituées de masses étalonnées) a été estimée égale à 0,005 mg.
- Masses volumiques: les erreurs sur les masses volumiques des solides sont considérées comme négligeables.
- Masse volumique de l'air humide (ϱ_a)

Il est important de faire la distinction entre:
- l'incertitude due à la formule elle-même;
- l'incertitude due aux grandeurs mesurées lors de l'application de la formule.

Incertitude due à la formule de calcul

Le calcul de ϱ_a, est effectué suivant la formule reprise du Rapport du BIPM (81/8); par conséquent, l'incerti-

tude sur ϱ_a résulte des incertitudes relatives aux valeurs de R, M_a, M_v et des incertitudes relatives aux valeurs tabulées de Z, p_{sv} et f. Au total, il subsiste sur ϱ_a une incertitude qui entraîne une erreur systématique dont la limite supérieure peut être estimée à $5 \cdot 10^{-5}$ [5], ce qui est à considérer comme négligeable.

Incertitude due aux paramètres mesurés

L'incertitude due à la mesure de la température (dans l'enceinte de la balance) donnée dans le certificat d'étalonnage est de 0,1 °C. Etant donné que la lecture des thermomètres est faite par la lunette, on peut considérer comme négligeable l'erreur résultant de la lecture proprement dite. La mesure de la température donne sur ϱ_a une incertitude relative estimée à 0,00081.

L'incertitude due à la mesure de la pression donnée dans le certificat d'étalonnage est de 0,1 torr. Il faut tenir compte également de l'incertitude de lecture (positionnement du ménisque) estimée à 0,05 torr, de l'incertitude sur la température relevée sur le thermomètre qui se trouve au milieu de la hauteur du baromètre, estimée à 0,5 °C, et enfin de l'incertitude de lecture de ce thermomètre (0,25 °C). Par conséquent, il en résulte une incertitude relative sur ϱ_a de 0,00012.

L'incertitude due à la mesure de l'hygrométrie a été estimée à 4 % ce qui entraîne sur ϱ_a une incertitude relative de 0,00023.

Incertitude due à la variation des paramètres au cours de la mesure

La température, la pression et l'humidité ont été mesurées au début et à la fin de la série de mesures, ce qui a généré une erreur supplémentaire. Pour la température, ont été observées des variations de 0,1 °C au cours d'une série de mesures; étant donné que cette variation n'est pas régulière, on a simplement majoré l'incertitude due à la mesure de la température. Pour les autres paramètres, on a observé que l'incertitude due à leurs variations était négligeable par rapport à l'incertitude relative à leurs valeurs.

En tenant compte de ce qui a été exposé ci-dessus, on peut estimer l'incertitude relative sur ϱ_a par:

$$u_{\varrho a} = [(1 \times 10^{-5} \times \Delta p)^2 + (4 \times 10^{-3} \times \Delta t)^2 + (9 \times 10^{-3} \times U)^2]^{1/2} = 0{,}00083$$

L'incertitude sur la correction de poussée de l'air est donnée par la formule :

$$u_{Ca}^2 = [m_r \frac{\rho_r - \rho_t}{\rho_r \rho_t} u_{\rho a}]^2 + (m_r(\rho_a - \rho_o))^2 [\frac{u_{\rho r}^2}{\rho_r^4} + \frac{u_{\rho t}^2}{\rho_t^4}]$$

avec:
- ρ_a: masse volumique de l'air humide
- ρ_o: 1,2 kg m^{-3}
- ρ_r: masse volumique de l'étalon national P_2
- ρ_t: masse volumique de l'étalon à comparer
- m_r: valeur nominale de la masse des étalons

Le deuxième terme peut être considéré comme négligeable. Ainsi, on obtient pour l'incertitude u_{Ca} la valeur de 0,069 mg.

L'incertitude sur la mesure du déséquilibre final de la balance (notée par E) comporte une partie aléatoire, due principalement au manque de fidélité de la balance, et une partie systématique provenant d'une incertitude sur la sensibilité de la balance.

La partie aléatoire (erreur d'appréciation du déséquilibre) se détermine d'après l'écart-type expérimental sur la moyenne d'une série de quatre mesures. On obtient 0,063 div. ce qui donne, converti en milligrammes, un écart-type sur E de 0,002 mg.

La partie systématique est déterminée par le calcul initial des déséquilibres e_1, e_2, e_3 et e_4 (qui sont des valeurs moyennes pour les déséquilibres partiels), connaissant la sensibilité de la balance; on mesure le déplacement ΔL correspondant a une surcharge Δm placée sur un des plateaux de la balance; cette mesure de sensibilité présente une importance d'autant plus grande que le déséquilibre global E [$E = (e_1 - e_2 - e_3 + e_4)/4$] a une valeur plus élevée. "E" ayant une valeur de l'ordre de 0,1850 mg, une erreur de 1 % sur la sensibilité se traduit par une erreur de 0,002 mg sur la masse de l'étalon à comparer. La valeur de l'échelle de la balance (moyenne) a été de 0,03 mg.

L'erreur résiduelle dans l'obtention des résultats des équations, dans les conditions de répétabilité, a été considérée comme égale à 0,058 mg.

Estimation de l'incertitude globale

L'incertitude globale et l'incertitude stricte ont été calculées comme expliqué dans les Tableaux 1 et 2, avec le facteur K = 2, en utilisant comme guide le document ISO/TC 69/SC 6 *Measurement uncertainty* [6].

Tableau 1: Sources et composantes de l'incertitude standard et de l'incertitude globale

	COMPOSANTES DE L'INCERTITUDE EXPRIMEES EN mg		
	Composantes de l'incertitude qui résultent des erreurs aléatoires et des erreurs locales systématiques		Composantes de l'incertitude qui résultent des erreurs strictes systématiques
SOURCES D'ERREUR	ALEATOIRE s_{alj}	LOCALE SYSTEMATIQUE s_{lsj}	σ_{ssj}
Etalon national P_2			0,0023
Masses utilisées comme surcharges			0,005
Poussée de l'air		0,069	
Mesure du déséquilibre final	0,002	0,002	
Erreur résiduelle	0,058		
	INCERTITUDE STANDARD $u = \sqrt{(\Sigma s_{alj}^2 + \Sigma s_{lsj}^2 + \Sigma \sigma_{ssj}^2)} = 0,09$ mg		
	INCERTITUDE GLOBALE $U = K\sqrt{(\Sigma s_{alj} + \Sigma s_{lsj}^2 + \Sigma \sigma_{ssj}^2)} = 0,18$ mg		

Tableau 2: Sources et composantes de l'incertitude standard et de l'incertitude stricte

	COMPOSANTES DE L'INCERTITUDE EXPRIMEES EN mg		
	Composantes de l'incertitude qui résultent des erreurs aléatoires et des erreurs locales systématiques		Composantes de l'incertitude qui résultent des erreurs strictes systématiques
SOURCES D'ERREUR	ALEATOIRE s_{alj}	LOCALE SYSTEMATIQUE s_{lsj}	σ_{ssj}
Etalon national P_2			0,0023
Masses utilisées comme surcharges			0,005
Poussée de l'air		0,069	
Mesure du déséquilibre final	0,002	0,002	
Erreur résiduelle	0,058		
	$\sqrt{U_{al}^2 + U_{ls}^2} =$ $K\sqrt{(\Sigma s_{alj}^2 + \Sigma s_{lsj}^2)} = 0,18$ mg		$U_{ss} = K\,\Sigma\sigma_{ss} =$ 0.0146 mg
	INCERTITUDE GLOBALE $U_{stricte} = \sqrt{U_{al}^2 + U_{ls}^2} + U_{ss} = 0,18 + 0,0146 = 0,19$ mg		

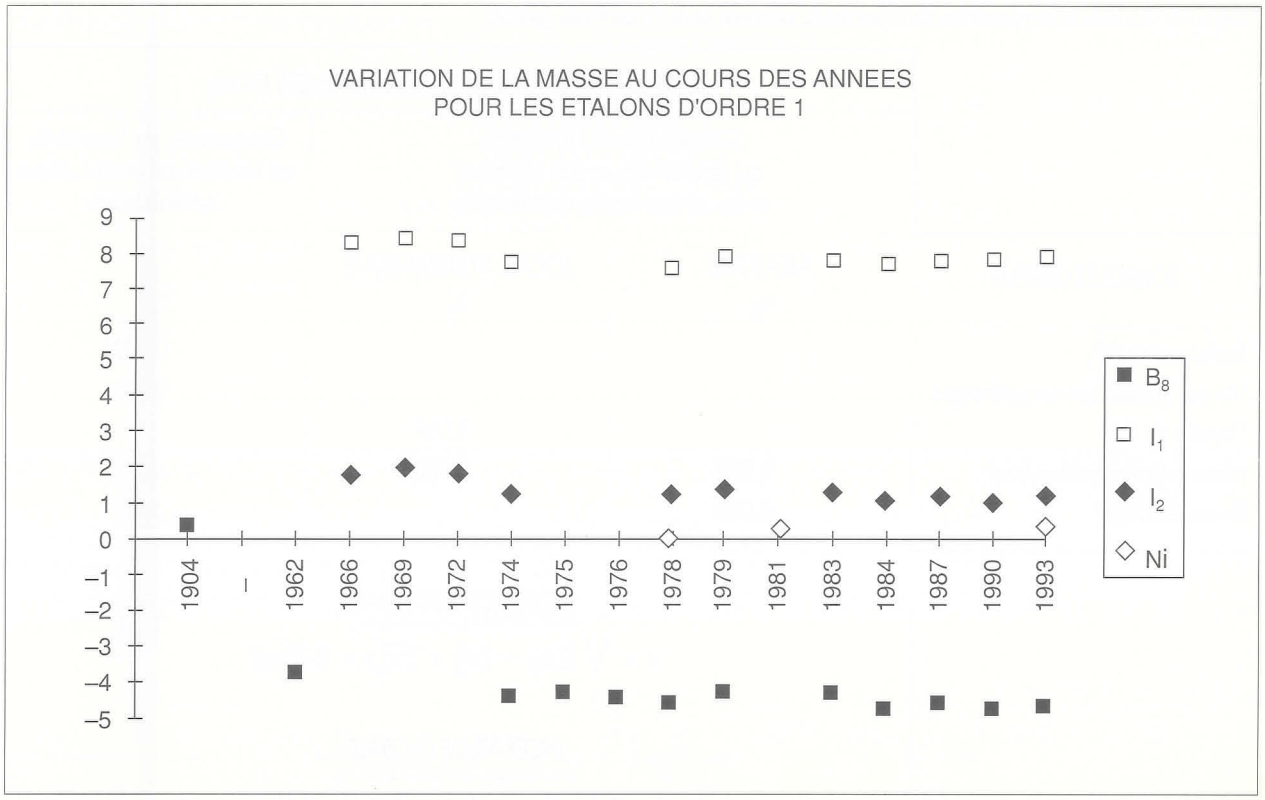

Fig. 4 Variation de la masse pour les étalons qui ont été comparés à l'étalon national P_2.

Résultats finaux

Les mesures effectuées ont conduit aux résultats suivants, en tenant compte de l'estimation de l'incertitude globale pour K = 2.

B_8 = 1 kg – 4,69 mg ± 0,18 mg
Ni = 1 kg + 0,24 mg ± 0,18 mg
I_1 = 1 kg + 7,85 mg ± 0,18 mg
I_2 = 1 kg + 1,18 mg ± 0,18 mg

Dans le diagramme de la Fig. 4, on peut voir la variation de la masse pour les étalons qui ont été comparés à l'étalon national P_2 depuis 1904.

Conclusions

Conformément au certificat du BIPM, le prototype national P_2 appartenant à la Roumanie a dépassé la valeur imposée par la Première Conférence Générale Des Poids et Mesures en 1889 (1 kg ± 1 mg).

Néanmoins, il a été utilisé dans les comparaisons avec sa nouvelle valeur et les résultats obtenus semblent satisfaisants.

On peut considérer qu'en apportant un certain nombre d'améliorations dans le fonctionnement de la balance et dans la détermination des paramètres d'environnement (en utilisant des appareils plus performants), l'incertitude sur la mesure des kilogrammes pourrait être réduite. ■

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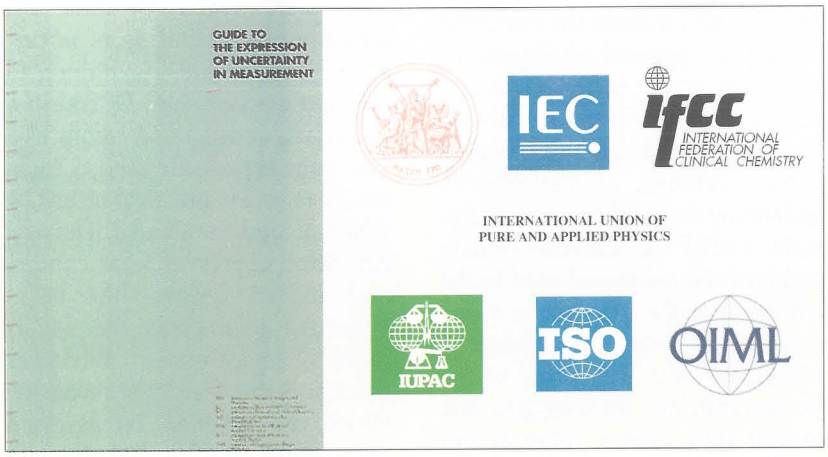
Doubts about uncertainty removed

THE EXPRESSION OF UNCERTAINTY IN MEASUREMENT: A NEW GUIDE

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



If the result of a measurement is important, then so is the estimate of its "quality" which is normally expressed (inversely) as an uncertainty.

EVERYONE professionally engaged in measurement is aware of the term *uncertainty,* and may be accustomed to reporting the uncertainty of his results. Unfortunately, however, there was little agreement in the past as to how the uncertainty of a result should be estimated and expressed; the practical significance of the term in a particular context was often unclear, and it was difficult to assess the comparative qualities of different measurements of the same quantity.

That difficulty was acute in relation to the results reported by different national laboratories, which led to a request to the *Bureau International des Poids et Mesures (BIPM)* to create a forum in which the matter could be discussed and a recommendation formulated that would enable uncertainty to be expressed in a form that was universally recognized and understood.

THE CIPM RECOMMENDATION

Eleven national standards laboratories collaborated in the production in 1980 of the draft CIPM Recommendation entitled *Expression of experimental uncertainties.* This document was approved by the *Comité International des Poids et Mesures (CIPM)* the following year and reaffirmed by that body in 1986.

The Recommendation, which extends to half a printed page, essentially says that the components of uncertainty should be expressed as standard deviations, either by the application of statistical methods to relevant data or by other means, and *'the combined uncertainty should be characterized by the numerical value obtained by applying the usual method for the combination of variances. The combined uncertainty and its components should be expressed in the form of "standard deviations".'* It concludes by saying: *"If, for particular applications, it is necessary to multiply the combined uncertainty by a factor to obtain an overall uncertainty, the multiplying factor used must always be stated."*

IMPLEMENTING THE CIPM RECOMMENDATION

The *Guide to the Expression of Uncertainty in Measurement* has been produced by representatives of the two international institutions

specializing in metrology (BIPM and OIML) and the leading international technological institutions (ISO, IEC, IUPAC, IUPAP, IFCC), meeting under the auspices of the Technical Advisory Group on Metrology (TAG 4) of ISO. It puts flesh on the bones of the CIPM Recommendation and is intended as an authoritative manual for that Recommendation's implementation.

The *Guide* is, however, more than a mere manual, for it re-examines the notion of uncertainty as a metrological (and therefore strictly practical) concept, and draws a clear distinction between **uncertainty** and **error.** Indeed it is the failure always to appreciate that distinction that has led in the past to so much loose vocabulary and resultant confusion.

"ERROR" IS OF SMALL RELEVANCE

The *Guide* makes little use of the term **error** because, it is argued, uncertainty is a parameter that is applied to a result from which any error has been eliminated, so far as it is known, by correction. The uncertainty has to be estimated from what is known about the measurement, rather than from speculation about an unknown residual error.

Past writings on the subject have made much use of terms such as **random error,** whose estimated standard deviation is said to be a component of uncertainty; but that standard deviation is in fact that of the repeated, randomly differing results, so that the concept of random error is never actually used in the calculation of the component uncertainty.

THE CONCEPT OF UNCERTAINTY

The working group that had the responsibility of producing the *Guide* spent some time seeking a definition of the concept of uncertainty that was fully consistent with the nature of measurement as a practical activity, and with the means by which uncertainty must necessarily be assessed.

Those means include the corrected results of repeated observations, knowledge of the reproducibility of results, of the characteristics of measuring instruments, of some human failings, of the physics underlying the method of measurement, and of the reliability of data obtained elsewhere and used in the reduction of the data of the measurement; they do not include any knowledge of a 'true value' of the measurand; nor do they give any insight into such a value except insofar as the corrected result of measurement is its best available estimate.

A PRACTICAL CONCEPT

Uncertainty is a parameter expressing the reliability of a measurement result, and that reliability must be assessed against the probability of measurement (not necessarily by the same means) giving other results for the same measurand. The subject under discussion is, after all, the expression of uncertainty *in measurement,* and the only guide to that uncertainty is what measurement, in its broadest practical concept, can achieve.

More precisely **uncertainty** is a parameter of the probability distribution of values that measurement (by all acceptable means) might reasonably attribute to the measurand, including at its centre the 'best estimate' that has been obtained. (This is a slight enlargement by way of explanation – but it is not an extension – of the definition given in the *Guide* and in the *International Vocabulary of Basic and General Terms in Metrology.)*

Some traditionalists have been unnecessarily vexed by this apparently new definition of uncertainty, because of its failure to mention a 'true value'. Of course a theoretical concept that embraces a true value is perfectly valid as such, but there are no practical means by which it can be evaluated. The new definition expresses what can be, and indeed always has been, evaluated to express the uncertainty of measurement. Whatever concept is discussed, the means by which uncertainty is assessed remain the same in that they are necessarily and exclusively based on knowledge gained, perhaps indirectly, by actual observation.

ESTIMATION OF UNCERTAINTY

The combined uncertainty of a measurement result may have many components. The measurement may require that several different observed quantities be measured (each contributory measurement having its own contributory uncertainty) and the results combined in a mathematical algorithm to give the desired result of measurement. Corrections may be applied, and the uncertainty in their estimation also contributes to the uncertainty of the result. The algorithm, which represents the relationship between the observed

quantities and the quantity that is the measurand, may itself be of uncertain perfection.

Each of the component uncertainties must be evaluated as the standard deviation of the probability function of the 'component' value. This *probability* is not an 'absolute' function that is independent of the observer; it is he who assigns it a probability distribution based on his limited knowledge of and assumptions concerning the circumstances surrounding the event. (If the observer had unlimited knowledge he would know a 'correct' result, and all other values would have zero probability!)

DIFFERENT WAYS OF EVALUATING UNCERTAINTY COMPONENTS

For example, a measurement may require repeated observations of the indications of a calibrated measuring instrument that is applied to a quantity (the stimulus) that the observer has reason to believe is of constant value during the period of the observations.

The results of the observations differ one from another because of influence quantities that the observer is unable to control or to measure, in an apparently random fashion. He may assume that the differences are indeed random and that the number of observations and the length of time in which they were taken are adequate to provide him with a sufficiently representative sample of the probability distribution of the result of observation. He then applies statistical analysis to the results to obtain an estimate of the standard deviation of the result.

That estimate is not, however, entirely objective, because of the subjective beliefs and assumptions on which it relies; only the instrument's indications, the statistical theorem and the arithmetic are entirely objective.

In a second example there may be a single observation of an uncalibrated instrument that has been newly verified to have errors (as legal metrologists use the term) that do not exceed the maximum errors permitted by a written standard for the instrument.

The observer has no reason to believe that any particular error within the permitted range of errors is more likely than any other, and he assumes that the verification is correct (that is, the errors do not lie outside the permitted range). His estimate of the probability function for the error as defined is thus what is called in the trade a 'rectangular' one, and its standard deviation can be shown to be $\mathbf{1/\sqrt{(12)}}$ times the width of the permitted error band. As in the first example the estimated standard deviation is not objective, for the same reasons.

In the first example the estimated standard deviation is 'frequency based' and its method of evaluation is called Type A in the CIPM Recommendation; in the second it is not – its evaluation is called Type B. Both are based on observations, subjective assumptions and irrefutable mathematics, and the *Guide* makes no distinction between the two types when their results are combined to determine the combined uncertainty of a result of measurement.

The *Guide* offers much advice on the estimation of components of uncertainty, and on how they are combined to give the standard combined uncertainty, with numerous examples. It also discusses how a *k*-factor may be chosen, that is, a factor by which the standard combined uncertainty (expressed as one standard deviation) may be multiplied to give an extended uncertainty that embraces almost all the values that may reasonably be attributed to the measurand, with a probability close to one.

REPORTING UNCERTAINTY

It is important that an estimate of uncertainty be reported in a standard way, so that there is no doubt as to the significance of the value reported. The amount of detail given in the report of an uncertainty depends on the extent to which the measurement is a routine one or a very particular one.

For example a measurement of a universal constant, for which many measurement results already exist, must be accompanied by a very detailed account of how the uncertainty has been estimated: the details required are listed in the *Guide*. On the other hand a routine calibration might be accompanied by a value for the uncertainty and a reference to a document detailing how the uncertainties of all similar calibrations performed in the laboratory concerned are derived.

The CIPM Recommendation and the *Guide* require that all uncertainties of measurement results be reported either as standard deviations, or as multiples of standard deviations accompanied by a statement of the multiplying factor (*k*-factor). There is no option to report an interval and a level of confidence, which would imply a knowledge, in addition to that of the standard deviation, of the

'shape' of the probability distribution.

However, a *k*-factor may be chosen to give an approximate level of coverage based on certain assumptions about the probability distribution, the most common being that it is 'normal' or gaussian. That assumption may be well justified if there are numerous components of uncertainty of comparative importance.

THE SIGNIFICANCE FOR LEGAL METROLOGY

Traditionally, measuring instruments that are subject to legal pattern approval and verification are verified to have *errors* that do not exceed the *maximum permissible errors*. The term *error* is defined as 'result of measurement minus a conventional true value', that is to say the indication of the instrument minus a reference value given by a standard. The term is not used in any idealistic sense of 'true value'; it is practical and unambiguous and in no way incompatible with the *Guide*.

However, it is also necessary to specify the quality of the standard with which instruments to be verified are to be compared. In existing OIML Recommendations that is done either by specifying maximum permissible errors for the standard, or by specifying a maximum uncertainty for it.

If the first method is chosen, then in principle the quality of the higher standard against which the standard is calibrated, and indeed the quality of the methods of comparison, should also be specified. It is more logical and convenient, now that there is international recognition of what the term means, to specify a maximum combined uncertainty of the standard and method of comparison. Thus the *Guide* has direct application to the standard instruments used, and how they are used, for verification in legal metrology.

The simplest way to report an uncertainty is as a 'standard combined uncertainty': a standard deviation; but presentationally that may be undesirable, for it gives values that are substantially smaller than currently quoted 'confidence intervals'. To the uninitiated it might give the false impression that standards of higher quality were being demanded than heretofore.

I suggest therefore that a *k*-factor of 2 be applied, that is, that an expanded uncertainty should be specified equal to two standard deviations. Such an uncertainty may be expected to encompass approximately 95 % of all the values that could reasonably be attributed to the measurand, assuming a normal probability distribution.

The *Guide* is intended for all practitioners of measurement, including those working at the frontiers of metrological physics, in calibration laboratories and in test houses. Some of it may be inapplicable to laboratories where legal metrology is practised, and may appear daunting; nevertheless legal metrologists should study its principles; when calibrating instruments they should follow its requirements; where they specify instruments and their use as standards they should do so in conformity with the *Guide*.

Discussions are already taking place as to how a number of briefer and simpler documents, possibly international standards and each applicable to a particular field of metrology, may be produced. Such documents must necessarily be entirely consistent with the principles of the *Guide*, and thus with those of the CIPM Recommendation. ■

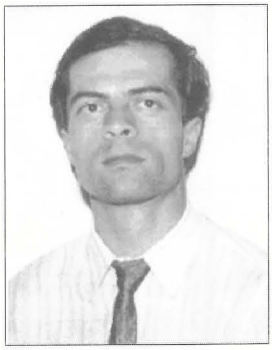
REFERENCE

Guide to the expression of uncertainty in measurement. First edition 1993. ISBN 92-67-10188-9. International Organization for Standardization.

Verification progress in Portugal

A LORRY APPLIED TO THE VERIFICATION OF WEIGHBRIDGES

M. DELGADO, Técnico Superior, Delegação Regional da Indústria e Energia de Lisboa e Vale do Tejo



In Portugal there are five Regional Departments of Industry and Energy[1] centralized in Porto, Coimbra, Lisboa, Évora and Faro (Fig. 1), which are in charge of legal metrology activities. These services verify and control many kinds of instruments, such as industrial manometers, weighbridges, and gasoline pumps. In addition, these departments are responsible for calibrating weights, measuring industrial noise, lengths, and volumes, etc.

All the sectors have been appreciated, but that of the weighbridges in the DRIELVT region has been particularly important in its development.

Fixed weighing instruments of maximum capacity from 20 tons to 100 tons or more, known as weighbridges, are normally used to check loads that are transported by lorry or train.

The goal is to obtain a correct measurement of the gross weight of the lorry and the net weight of the charge by knowing the tare of the lorry. It is also possible to connect the weighing instruments to computer systems, allowing for a more efficient control and management of the product.

USING THE LORRY FOR WEIGHBRIDGE VERIFICATIONS

To control the weighbridges, most of the Portuguese regional departments have a special lorry (Fig. 2) and individual, calibrated, class M_1 weights of 1 000 kg (about 18 weights).

The lorry can transport those weights and is equipped with a crane to remove them (Fig. 3). The lorry weighs 32 gross tons, and has four axles (2 directional axles); it is also equipped with a 11 020 cm^3 diesel engine which develops about 360 Cv. The weights have a cubic shape and can therefore be easily handled with a fork lift (Fig. 4). The lorry transports small weights (20 kg) for making supplementary adjustments and checks.

The lorry permits a higher quality of the verification service by increasing the number of weighbridge verifications; that purchased by our service makes it possible to verify a weighbridge up to a maximum capacity of 40 tons without substituting the loads. With this lorry it is possible to transport standard weights and carry out two or more verifications per day (which was not previously possible).

Fig. 1 The five Regional Departments of Industry and Energy which carry out legal metrology activities in Portugal.

1 DRIEN: Delegação Regional da Indústria e Energia do Norte.
DRIEC: Delegação Regional da Indústria e Energia do Centro.
DRIELVT: Delegação Regional da Indústria e Energia do Lisbona e Vale do Tejo.
DRIEAL: Delegação Regional da Indústria e Energia do Alentejo.
DRIEA: Delegação Regional da Indústria e Energia do Algarve.

Fig. 2 The lorry used as a substitution load during the verification of a weighbridge in Portugal.

ANALYSING THE RESULTS

By analysing the evolution of weighbridge verifications during the last three years (Table 1), an increase in the number of verifications between two periods can be remarked: before purchase of the lorry and after purchase of the lorry.

Table 1 Number of weighbridge verifications (DRIELVT).

YEAR / MONTH	1991		1992		1993		1994	
January	13		19		13		24	
February	15	**44**	24	**60**	15	**49**	36	**95**
March	16		17		21		35	
April	19		16		21		27	
May	15	**51**	12	**46**	17	**58**		
June	17		18		20			
July	13		18		28			
August	13	**35**	4	**35**	24	**69**		
September	9		13		17			
October	15		19		24			
November	20(1)	**49**	20	**58**	25	**73**		
December	14		19		24			
TOTAL	**179**		**199**		**249**			

1 Beginning of lorry usage

It is interesting to notice that the previous maximum level of 20 weighbridges per month was exceeded with the use of the lorry which was purchased in November 1991.

The progress of the number of weighbridge verifications carried out by DRIELVT during the last three years is shown by the following:

- 1991 - 14.5 weighbridges/month;
- 1992 - 16.6 weighbridges/month;
- 1993 - 20.7 weighbridges/month.

By comparing the situation in 1991 and 1993, it can obviously be concluded that the volume of verifications per year increased: 70 more weighbridges were verified in 1993 which corresponds to a 43.2 % increase. These results demonstrate the improvement experienced by our service due to the use of the lorry for verification of the weighbridges. ■

Fig. 3 Cubic standard weights lifted by using a crane.

Fig. 4 Cubic standard weights lifted by means of a fork lift.

OIML in perspective

DO YOU KNOW ABOUT THE BIML?

L'OIML en perspective

CONNAISSEZ-VOUS LE BIML?

WHEREAS the *Comité International de Métrologie Légale* (CIML) operates as the "steering committee" for OIML, the *Bureau International de Métrologie Légale* (BIML) is the administrative engine that ensures the general operation of OIML. Established in Paris in accordance with Article III of the *Convention establishing the Organisation International de Métrologie Légale* (October 1955), BIML is the headquarters for OIML.

BIML: BUREAU. INFORMATION. MANAGEMENT. LIAISON

The BIML is multifaceted in its scope.
One of the most important aspects of the Bureau is its secretarial work which includes organising Conference and Committee meetings and technical seminars, publishing OIML International Recommendations and Documents and other publications, and informing CIML Members of work carried out by the technical committees and subcommittees. The Bureau assists the CIML Members in implementing decisions and manages the financial situation of OIML. Maintaining liaisons with regional and international bodies whose activities are connected with those of OIML counts among the numerous responsibilities of BIML.

TECHNICAL ACTIVITIES

The Bureau contributes actively to OIML technical work by participating in meetings of technical committees and subcommittees, assisting in the application of the new *Directives for OIML technical work,* and maintaining relations with other institutions. By focusing on matters concerning the

ALORS que le *Comité International de Métrologie Légale* (CIML) est le "comité directeur" de l'OIML, le *Bureau International de Métrologie Légale* (BIML) est le moteur administratif qui assure le fonctionnement général de l'OIML. Etabli à Paris en accord avec l'Article III de la *Convention instituant une Organisation Internationale de Métrologie Légale* (octobre 1955), le BIML est le siège administratif de l'OIML.

BIML: BUREAU. INFORMATIONS. MANAGEMENT. LIAISONS

Le domaine d'activité du BIML possède de multiples facettes. Un des aspects les plus importants du Bureau est son travail de secrétariat qui inclut l'organisation de la Conférence et des réunions du Comité, des séminaires techniques, la publication des Recommandations et Documents Internationaux et brochures diverses, ainsi que l'information des Membres du CIML concernant les travaux effectués par les comités techniques et sous-comités. Le Bureau aide les Membres du CIML dans la mise en application des décisions de celui-ci et gère la situation financière de l'OIML. Le maintien des liaisons avec les organismes régionaux et internationaux dont les activités sont connexes à celles de l'OIML compte parmi les nombreuses responsabilités du BIML.

ACTIVITES TECHNIQUES

Le Bureau contribue activement au travail technique de l'OIML en participant aux réunions des comités techniques et sous-comités, en développant le Système de Certificats OIML, en veillant à l'application des nouvelles *Directives pour les travaux techniques de l'OIML,* et en maintenant des relations avec les autres institu-

communications of the Organisation, BIML has recently implemented new strategies for promoting OIML activities and encouraging increased exchanges of information with other bodies concerned with legal metrology.

OIML BULLETIN

The OIML Bulletin is published by BIML and distributed free of charge to Member States and Corresponding Members and on a subscription basis to other readers. This journal was initially created as a tool for keeping CIML Members informed of OIML activities but throughout the years, the readership for the Bulletin has expanded. With a global circulation of 1 300 copies, the Bulletin serves as an important source of information concerning OIML's state of progress, technical advances made in the field of legal metrology, activities of other regional and international bodies, and trends occurring in the metrological community.

DOCUMENTATION CENTER

Maintaining archives and documenting information of interest to OIML is another task of BIML and a documentation center was established to this end. Information and documents are provided for Member States and Corresponding Members on request. Due to limited space and human resources, the documentation center is not open to the public.

THE BIML TEAM

In comparison to the secretariats of other international organizations, BIML has a small staff of 10 persons (see pp. 33–35). The Director and Assistants are appointed by the CIML and other agents are appointed by the Director ; all contracts now have a duration of five years which may be extended thereafter.
In view of OIML's international character, an effort is made during recruitment to seek the widest geographical distribution of the staff members as possible. ■

tions. Par la mise au point des modes de communication de l'Organisation, le BIML a récemment mis en application de nouvelles stratégies afin de promouvoir les activités de l'OIML et d'encourager un échange croissant d'informations avec les autres organismes concernés par la métrologie légale.

BULLETIN OIML

Le Bulletin OIML est publié par le BIML; il est distribué gratuitement aux Etats Membres et Correspondants, et par abonnement à d'autres lecteurs. Ce journal a été créé initialement comme un moyen pour tenir informés les Membres du CIML des activités de l'OIML, mais au cours des années, l'audience du Bulletin s'est élargie; 1 300 exemplaires du Bulletin sont actuellement édités et constituent une source d'information sur les progrès de l'OIML, l'essor technologique dans le domaine de la métrologie légale, les activités des autres organismes régionaux et internationaux et les tendances de la métrologie future.

CENTRE DE DOCUMENTATION

La gestion des archives et l'enregistrement des informations d'intérêt pour l'OIML constituent une autre tâche du BIML; un centre de documentation a été établi dans ce but. Les informations et documents peuvent être obtenus sur demande des Etats Membres et Correspondants. Le centre de documentation n'est pas ouvert au public, à cause du personnel réduit et du manque de locaux disponibles.

L'EQUIPE DU BIML

Par comparaison avec les secrétariats d'autres organisations internationales, le BIML a un effectif réduit de 10 personnes (voir pp. 33–35). Le Directeur et les Adjoints sont désignés par le CIML et les autres agents sont nommés par le Directeur. Tous les contrats ont maintenant une durée de 5 ans et sont renouvelables. Etant donné le caractère international de l'OIML, un effort est fait lors des recrutements pour rechercher la répartition géographique la plus diversifiée possible pour les membres du personnel. ■

THE STAFF MEMBERS OF BIML AND YEAR OF RECRUITMENT

DIRECTOR
B. ATHANÉ (French)
1973

ASSISTANT DIRECTORS
A. VICHENKOV (Russian)
1991
PH. DEGAVRE (Belgian)
1992

ENGINEER
E. WEBER (French)
1990

COMMUNICATIONS
K. FRENCH (American)
1992

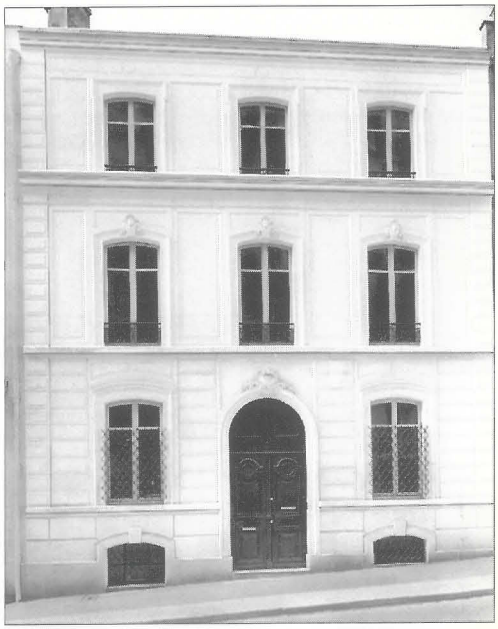
ADMINISTRATOR
PH. LECLERCQ (French)
1965

SECRETARIAT
M. ROBBE (French)
1962
N. CHASSELOUP (French)
1985

ARCHIVISTS
Y. CAURO (French)
1960
J. BOURGEOIS (French)
1978

Bernard Athané occuped the position of Director of BIML in 1974 after one year as Assistant Director.

Bernard Athané a pris les fonctions du directeur du BIML après une année comme adjoint au directeur.



The BIML pictured 30 years ago at its present location in Paris.

Le BIML il y a 30 ans à son emplacement actuel à Paris.

From left to right: Technical agents Kristine French, Edouard Weber, Philippe Degavre et Alexandre Vichenkov.

Ms French, Responsible for Communications, is in charge of the internal and external communications of the Organisation. She is co-Editor of the OIML Bulletin and is charged with the elaboration of a new general brochure for OIML. Ms French also works as editor/translator for the English versions of the documents published by BIML.

Mr Weber, Engineer, is the computer specialist for BIML and is responsible for the French versions of OIML Recommendations and Documents (editing and translating).

Mr Degavre, Assistant Director, is co-Editor of the Bulletin and is also charged with organizing OIML technical seminars, establishing liaisons for the technical activities of the TCs and SCs, and following-up on the activities of international standardization bodies; he participates in certain TC/SC meetings and those organized by Member States and liaison institutions.

Mr Vichenkov, Assistant Director, is charged with the follow-up and general evolution of the OIML Certificate System, liaisons with other international and regional institutions for the subjects of certification, accreditation and quality control, and matters concerning developing countries: the program for the OIML Development Council, the organization of training courses and the elaboration/revision of certain brochures; he also participates in the work of certain technical committees.

De gauche à droite: Agents techniques Kristine French, Edouard Weber, Philippe Degavre et Alexandre Vichenkov;

Mlle French, Responsable des communications, s'occupe des communications internes et externes de l'Organisation. Elle est co-Editeur du Bulletin OIML et s'occupe également de l'élaboration d'une nouvelle brochure pour l'OIML. Mlle French est responsable de la révision des versions anglaises des documents à publier par le BIML.

M. Weber, Ingénieur, est le spécialiste informatique du BIML et il effectue ou corrige les traductions françaises des Recommandations et Documents OIML.

M. Degavre, Adjoint au Directeur, est également co-Editeur du Bulletin OIML et est chargé des séminaires techniques de l'OIML, des liaisons à établir pour les travaux techniques des TC/SC, du suivi des activités des organismes internationaux de normalisation; il participe à certaines réunions des TC/SC ou à des séminaires ou réunions organisées par des Etats Membres ou des Institutions en liaison.

M. Vichenkov, Adjoint au Directeur, est chargé du suivi général et de l'avenir du Système de Certificats OIML, des liaisons avec d'autres institutions internationales et régionales en matière de certification, accréditation et contrôle de la qualité, des problèmes des pays en développement: programme du Conseil de Développement, cours de formation, brochures et liaisons avec d'autres organisations; il participe également aux travaux de certains comités techniques.

M. Leclercq, Administrator, is charged with the management and accounting of the Organisation, payments and sales, billing, personnel, and certain tasks associated with the OIML Bulletin such as subscriptions and mailing information.

M. Leclercq, Administrateur, est chargé de la gestion et de la comptabilité de l'Organisation, des paiements, des ventes, de la facturation et de la tenue des fichiers des destinataires du Bulletin OIML.

From left to right: Jacques Bourgeois and Yves Cauro, Archivists. Mr Bourgeois and Mr Cauro are responsible for maintaining the archives of the documentation center and performing tasks such as photocopying, offset printing, and messenger services.

De gauche à droite: Jacques Bourgeois et Yves Cauro, Archivistes; ils sont responsables de l'archivage au centre de documentation et effectuent les travaux de photocopies, de tirages offset et de services de messagerie.

From left to right: Nicole Chasseloup and Monique Robbe, Secretaries; they are responsible for carrying out traditional secretarial work which includes keeping records of all correspondence received in the Bureau, mailings, filing all correspondence from Member States, Corresponding Members, and liaison bodies, and organizing documents concerning the technical committees and subcommittees. In addition, they answer your telephone calls.

De gauche à droite: Nicole Chasseloup et Monique Robbe, les secrétaires du BIML; elles sont chargées du travail de secrétariat, de l'enregistrement du courrier, des expéditions, du classement des dossiers des Etats Membres et Correspondants, des Institutions en liaison, et relatifs aux travaux des comités techniques et sous-comités; en outre, elles vous répondent au téléphone.

activities OIML activités

TC 9

Instruments for measuring mass and density

Secretariat: USA

An informal meeting of the international working group of TC 9 (with the participation of experts of TC 9/SC 2) was held in Teddington, UK on 30 May 1994 in order to discuss the organization of TC 9, the work of the technical committee and its subcommittees, and the impact of *Directives for the technical work* on the activities of this TC.

Chairman: O. K. Warnlof, Technical Advisor, National Institute of Standards and Technology, USA.

Participation: 14 delegates representing 14 P-members of TC 9/SC 2; Ph. Degavre, Assistant Director of BIML.

Main Points

- The *Directives for the technical work* were explained in order to draw attention to a few important points: 2.9 which concerns the participation in the work of TCs and SCs, and 2.10 which concerns the rules to be applied when making decisions at TC or SC level.

  If decisions during a meeting are supported by a majority of P-members present, and this majority does not constitute a majority of registered P-members, the decisions shall be distributed for postal vote within one month after the meeting, allowing one month for a reply; a majority of all votes cast is required for this postal vote.

  It was also noted that in accordance with 4.1.1.5 of the *Directives* the secretariat should inform P-members of its nominee as chairperson at least one month before the meeting.

- Following a proposal of the French delegate, the question of a possible revision of OIML R 60 was considered; it was suggested that this Recommendation not be reviewed since the publication of Annex A to OIML R 60 *Test report format for the evaluation of load cells* now makes possible the OIML certification of load cells provided that they satisfy the metrological and technical requirements specified in OIML R 60.

- A possible revision of OIML R 74 *Electronic weighing instruments* was discussed.

- The preparation of draft annexes to OIML R 111 *Weights of classes* E_1, E_2, F_1, F_2, M_1, M_2, M_3 on test procedures and test report formats should be undertaken by a special working group constituted by the European Nordic countries (referred to as the "Nordic group").

- The responsibility for the secretariat of TC 9/SC 4 "Densities" was discussed. At present, no candidacies have been presented.

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TC 9

Instruments de mesure des masses et masses volumiques

Secrétariat: USA

Une réunion informelle du groupe de travail international du TC 9 (avec la participation des experts du TC 9/SC 2) s'est tenue à Teddington le 30 mai 1994 afin de discuter de l'organisation du TC 9, des travaux du TC 9 et de ses sous-

comités ainsi que de l'impact des Directives pour les travaux techniques sur ces travaux.

Président: O. K. Warnlof, Conseiller Technique, National Institute of Standards and Technology, USA.

Participation: 14 délégués représentant 14 membres-P du TC 9/SC 2; Ph. Degavre, Directeur Adjoint du BIML.

Points Principaux

- Les *Directives pour les travaux techniques* ont été expliquées afin d'attirer l'attention sur un certain nombre de points importants: le point 2.9 qui concerne la participation aux travaux des TC et SC, le point 2.10 relatif aux règles à appliquer pour prendre des décisions au niveau des TC/SC.

  Si, pendant une réunion, des décisions sont soutenues par une majorité des membres-P présents qui ne constitue pas une majorité des membres-P inscrits, les décisions doivent être communiquées pour vote par correspondance dans un délai d'un mois après la réunion, avec un délai de réponse d'un mois; pour ce vote par correspondance, la majorité de tous les votes exprimés est requise.

  Il fut également remarqué que, conformément au point 4.1.1.5 des Directives, le secrétariat doit informer les membres-P du Président proposé au plus tard un mois avant la réunion.

- Suite à une proposition du délégué français, la question d'une possible révision de la Recommandation OIML R 60 a été considérée; il a été suggéré de ne pas réviser cette Recommandation étant donné que la récente publication de l'Annexe A à la R 60 *Format des rapports d'essai des cellules de pesée* permet à ces capteurs de recevoir des certificats OIML s'ils satisfont aux exigences métrologiques et techniques spécifiées dans R 60.

- La révision possible de OIML R 74 *Instruments de pesage électroniques* a également été discutée.

- La préparation des projets d'annexes à la Recommandation OIML R 111 *Poids des classes E_1, E_2, F_1, F_2, M_1, M_2, M_3* sur les procédures et formats de rapports d'essai devrait être prise en charge par un groupe de travail spécifique constitué des pays européens scandinaves (qu'il est d'usage d'appeler "Groupe nordique").

- La responsabilité du secrétariat du TC 9/SC 4 "Masses volumiques" a été discutée: à ce jour, aucune candidature n'a été présentée.

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TC 9/SC 2

Automatic weighing instruments

Secretariat: United Kingdom

The technical subcommittee TC 9/SC 2 held a meeting in Teddington, UK 31 May–2 June 1994.

Chairman: Mr D. Jones, NWML

Participation: 14 delegates representing 14 P-members; 3 representatives of industry (Comité Européen des Constructeurs d'Instruments de Pesage: CECIP); Ph. Degavre, Assistant Director of BIML.

Main Points

- Revision of OIML R 61 *Automatic gravimetric filling machines*

  A 7th committee draft which included test procedures and test report formats was discussed; many comments were made on important matters such as maximum permissible errors, types of test load for pattern evaluation or for verification, etc. An 8th committee draft should be prepared by the secretariat and submitted for vote.

- Revision of OIML R 51 *Automatic catchweighers*

  A 6th committee draft which included test procedures and test report formats was discussed; since it appeared very difficult to obtain a majority of opinions on fundamental points such as the scope of this Recommendation, maximum permissible errors regimes and test procedures, it was decided to organize a meeting in Teddington in December 1994 in order to finalize the work at SC level by obtaining the required majority on new proposals from the secretariat.

- Annexes to OIML Recommendations R 106 and R 50.

  During this meeting, there was no time to examine the drafts

for test procedures and test report formats to be included in OIML R 106 *Automatic rail weighbridges* and in OIML R 50 *Continuous totalizing automatic weighing instruments;* the work should be finalized by postal consultation.

- Automatic road weighbridges; new OIML Recommendation project

  An initial paper was distributed before the meeting and is expected to be discussed by the international working group in the future.

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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 31 mai au 2 juin 1994.

Président: M. D. Jones, NWML

Participation: 14 délégués représentant 14 membres-P; 3 représentants de l'industrie (Comité Européen des Constructeurs d'Instruments de Pesage: CECIP); Ph. Degavre, Directeur Adjoint au BIML.

Points Principaux

- Révision de OIML R 61 *Doseuses pondérales à fonctionnement automatique*

  Un 7e projet de comité incluant les procédures d'essai et formats des rapports d'essai a été discuté; un grand nombre de commentaires ont été fait sur des matières aussi importantes que les erreurs maximales tolérées, les types de charges d'essai utilisées pour l'évaluation de l'approbation de modèle ou lors des vérifications, etc. Un 8e projet de comité devrait être préparé par le secrétariat et soumis au vote.

- Révision de OIML R 51 *Catchweighers* (aucune traduction française n'est disponible pour l'instant)

  Un 6e projet de comité incluant les procédures d'essai et formats des rapports d'essai a été discuté; étant donné qu'il est apparu très difficile d'obtenir une majorité claire sur des points essentiels comme le domaine d'application de cette Recommandation, les différentes formes d'erreurs maximales tolérées et les procédures d'essai, il a été décidé d'organiser une réunion à Teddington en décembre 1994 afin de terminer les travaux au niveau SC, par l'obtention de la majorité requise, sur base de nouvelles propositions du secrétariat.

- Annexes aux Recommandations OIML R 106 et R 50

  Il ne resta pas suffisamment de temps pendant cette réunion pour examiner les procédures d'essai et formats des rapports d'essai à inclure dans les Recommandation OIML R 106 *Ponts-bascules ferroviaires à fonctionnement automatique* et OIML R 50 *Instruments de pesage totalisateurs continus;* les travaux devraient pouvoir se poursuivre et être terminés par correspondance.

- Ponts-bascules routiers à fonctionnement automatique; nouveau projet de Recommandation OIML

  Un document initial a été distribué avant la réunion; il devra être discuté plus tard par le groupe de travail international.

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TC 11

Instruments for measuring temperature and associated quantities

Secretariat: Germany

Technical Committee TC 11 (formerly Pilot Secretariat SP 12) held its first meeting in Berlin,

Germany 16–17 March 1994 with a view to establishing its sub-committees and work program.

Chairman: Dr M. Kühne, Physikalish-Technische Bundesanstalt, Germany

Participation: 17 delegates representing 9 P-members, 1 O-member; Prof. G.Sauerbrey, Director PTB Berlin; Dr S. E. Chappell, Vice-President CIML, USA; Dr M. Rantala, CIML Member, Finland; A. Vichenkov, Assistant Director of BIML.

Main Points

- The following structure, allocation of projects, and responsibilities for the secretariats were recommended (and approved by CIML Members by correspondence after the meeting). The revision of R 75 was established as p 1 for TC 11.

SC 1 Resistance thermometers
RUSSIA
p 1: Revision of R 84

SC 2 Contact thermometers
USA
p 1: Standardized thermocouples (USA, Slovakia)
p 2: Liquid-in-glass thermometers

SC 3 Radiation thermometers
RUSSIA
p 1: Review of R 18 (if necessary)
p 2: Revision of R 48

- Three projects on thermocouples of the former SP 12 program were combined in one project p 1 of TC 11/SC 2; certain other projects were either omitted or postponed to a later date. (The projects of former SP 12-Sr 7 constitute presently the program of TC18/SC2 "Medical thermometers").

- A visit to PTB laboratories of temperature standards showed the up-to-date instrumental basis for various tasks including those for TC 11 activities.

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TC 11

Instruments de mesure de la température et grandeurs associées

Secrétariat : Allemagne

Le TC 11 (ancien Secrétariat Pilote SP 12) a tenu sa première réunion à Berlin, Allemagne, les 16 et 17 mars 1994 afin d'établir ses sous-comités et son programme de travail.

Président: Dr M. Kühne, Physikalish-Technische Bundesanstalt, Allemagne.

Participation: 17 délégués représentant 9 membres-Participant, 1 membre-Observateur; Prof. G. Sauerbrey, Directeur du PTB de Berlin; Dr S. E. Chappell, Vice-président du CIML, U.S.A.; Dr M. Rantala, Membre du CIML, Finlande; A. Vichenkov, Adjoint du Directeur du BIML.

Points Principaux

- La structure, les attributions de projets et responsabilités des Secrétariats, donnés ci-après ont été retenus (et approuvés au niveau du CIML par correspondance suite à la réunion). La révision de R 75 a été établie comme p 1 pour le TC 11.

SC 1 Thermomètres à résistance
FÉDÉRATION RUSSE
p 1 : Révision de R 84

SC 2 Thermomètres de contact
USA
p 1 : Thermocouples normalisés (USA, Slovaquie)
p 2 : Thermomètres en verre, à liquide

SC 3 Thermomètres à radiation
FÉDÉRATION RUSSE
p 1 : Examen de R 18 (si nécessaire)
p 2 : Révision de R 48

- Trois projets sur les thermocouples du programme de l'ancien SP 12 ont été combinés dans le projet p1 du TC 11/SC 2; certains autres projets ont été soit omis soit reportés à plus tard. (Les projets de l'ancien SP 12-Sr 7 constituent le programme actuel du TC 18/SC 2 "Thermomètres médicaux").

- Une visite dans les laboratoires des étalons de température du PTB a montré un support instrumental de pointe pour divers travaux y compris les activités du TC 11.

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European cooperation in metrology

A REPORT ON RECENT MEETINGS AND DEVELOPMENTS OF OIML LIAISON BODIES

SPRING 1994 was a particularly important season for cooperation in metrology at European level: COOMET met in April, EUROMET and WELMEC met in May, and WECC held a joint meeting with WELAC at the end of May, slightly too late for permitting the inclusion of a report in this issue of this OIML Bulletin.

The Director of BIML participated as OIML observer at the meetings of COOMET, EUROMET and WELMEC. Following are brief reports on these three meetings.

COOMET
Bratislava (Slovakia)
19–20 April, 1994

Metrological cooperation already existed among the so-called "socialist" countries in the framework of the Standardization Committee of the Council for Mutual Economical Assistance. After the dissolution of CMEA, a new form of metrological cooperation was established following initiatives in which Dr Z. Referowski, former BIML Assistant Director and Polish CIML Member, played an essential role.

In fact, COOMET aims at reproducing, among Central and Eastern European countries, a cooperation similar to that which exists in Western Europe with EUROMET, WELMEC and WECC. It is even anticipated that COOMET may disappear as soon as its members are progressively integrated in Western bodies.

At present, COOMET includes the following countries: Belarus, Bulgaria, Germany, Poland, Romania, Russian Federation, Slovakia, Ukraine (all these countries having been represented at the Bratislava meeting) and Cuba and Mongolia; Lithuania attended the meeting although this country has not yet signed the Memorandum of Understanding establishing COOMET.

Most of the projects developed within COOMET concern intercomparisons of measurement standards and matters of traceability. In the field of legal metrology one project has concluded in the use of OIML R 106 for weighing in-motion of railways, and a new proposed project could aim at harmonizing the pattern evaluation procedures in Central and Eastern European countries to align them on the procedures used in Western Europe.

COOMET and BIML have signed an agreement of cooperation in April 1993. The present Chairman of COOMET, Dr Referowski, will retire in November 1994 and the elected Chairman is Dr Robert Spurny, Director of the Slovak Metrology Institute in Bratislava.

WELMEC
Oslo (Norway)
18–20 May, 1994

Some ten years ago, cooperation among Western European countries was conducted under a single body, the Western European Metrology Cooperation (WEMC), covering scientific, legal and calibration activities. Certain participants being more or less interested in one or two of these three disciplines, WEMC was disbanded and replaced by WELMEC, EUROMET (see below) and WECC.

WELMEC cooperates closely with OIML as well as with the Commission of the European Communities, responsible for developing European regulations known as "Directives" which are mandatorily implemented by the members of the European Union.

During the 8th WELMEC Committee meeting, the following main matters were discussed:

- implementation of the European Directives of nonautomatic weighing instruments and of the accompanying European Standards EN 45501 (which is practically a copy of OIML R 76-1)
- WELMEC agreement of automatic weighing instruments following which a national pattern approval based on OIML Recommendations (or, in some cases, draft Recommendations) is accepted by other members
- future extension of this agreement to other categories of instruments (measuring system for liquids, gas meters, etc.)
- possible development of a Directive covering all instruments that are subject to legal controls
- establishment of a data base for EC pattern approvals
- preparation of a directory of European Legal Metrology Services (an updated version of this directory is expected to be available by the end of the year and relevant information will be published in the OIML Bulletin).

The OIML representative participated in the discussions and

gave information concerning the progress of OIML activities of interest for WELMEC countries.

A proposal to hold a joint WELMEC-OIML seminar dealing with the verification of weighing instruments is under consideration; the proposed date is September 1995, and that seminar could be connected with a WELMEC Committee meeting.

The following countries participated in the 8th WELMEC Committee meeting: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom.

The present Chairman of WELMEC is Dr S. Bennett, UK CIML Member, and the secretariat is held by NWML.

EUROMET
Oslo
19–20 May, 1994

EUROMET's main purposes are the organization of intercomparisons and traceability projects in various fields of metrology as well as cooperative research for the realization of units and the development of new measurement standards.

The fields of work (length, time and frequency, amount of substance, mass, etc.) are similar to those covered by the Consultative Committees of the *Comité International des Poids et Mesures*. Therefore, there is a strong synergy between EUROMET and BIPM whereas the interaction with OIML is limited.

The BIML Director gave some information concerning developments in OIML that could be of interest for EUROMET members; they mainly concerned the OIML long-term policy and the OIML Bulletin.

In addition to the EUROMET members (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom), five international or regional organizations attended the Oslo meeting: BIPM, COOMET, WELMEC, the European Commission and BIML.

Up to present, the European Chairman was Prof D. Kind, President of PTB, Germany. The newly elected Chairman is Dr Kim Carneiro, Director, Danish Institute of Fundamental Metrology. ■

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Calibrating flowmeters in the "Age of ISO 9000" – J. SCHADLICK, (EGB&G Instr. Flow Technol., Phoenix, AZ, USA), J. RUESCH I&CS (USA), vol. 67, no. 1, pp. 61–4 (1994).

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

CIML

The 29th meeting of the *Comité International de Métrologie Légale* will be held 12–14 October 1994 at the *Maison de la Chimie*, 28, rue Saint Dominique, 75007 Paris. Opening session will begin at 10:00 (Wednesday the 12th). The meeting of the Development Council will be held 10–11 October 1994 at the same location.

Note: These meetings are closed to the public.

NEW SUBCOMMITTEE

FRANCE has accepted responsibility as secretariat of a new subcommittee, TC 17/SC 7, which will cover the subject of **breath testers.**

Expo in Japan

The **TEPIA 7th Exhibition 'Intelligent Measurement'** is being held from April 28 to December 16, 1994 in Tokyo. This Exhibition is sponsored by the Machinery and Informations Industries Promotion Foundation and supported by MITI. TEPIA, abbreviated from Technology Utopia, is located at 2-8-44, Kita-Aoyama, Minato-ku, Tokyo (Tel: 03-5474-6111) and is open 10:00-18:00 Monday-Friday and 10:00-17:00 Saturday, closed on Sundays.

EVERYTHING STARTED WITH MEASUREMENTS

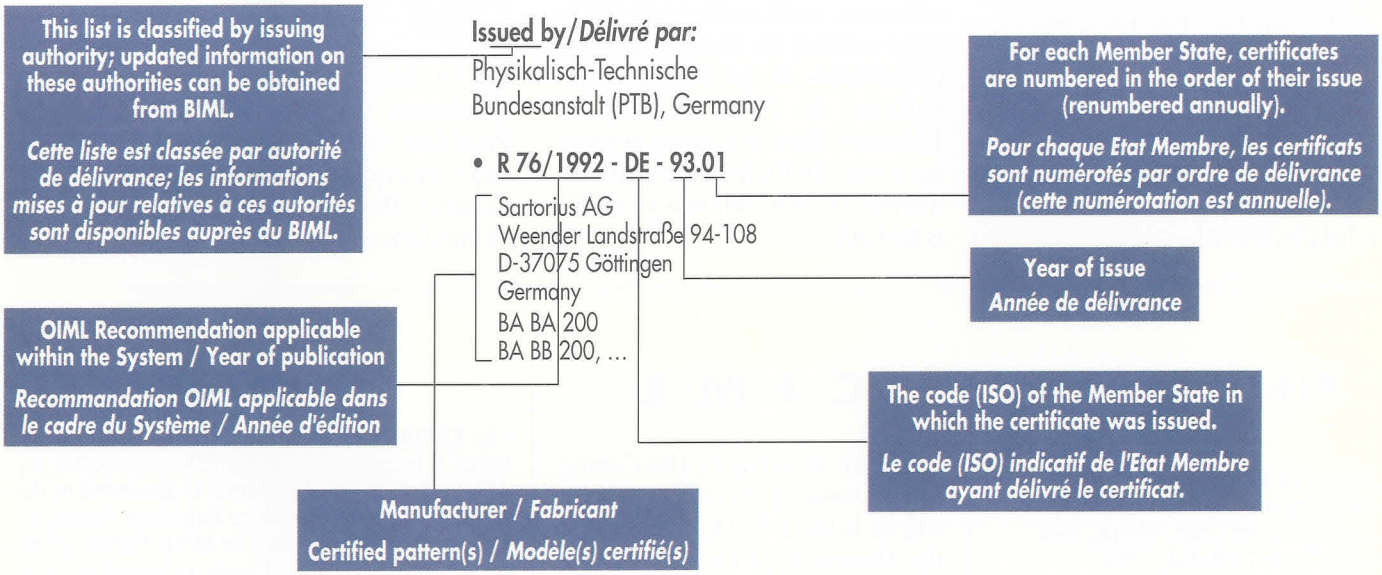
People began to "measure" by comparing lengths and weights so that they could understand the natural things around them better and so conceived the idea of quantifying things and phenomena by using "numbers". As the "measuring tools" developed and increased in variety and number, the objects measurement expanded limitlessly. "Measurement technology", which was developed along with the requirements of the time, has accumulated the best knowledge of the aeons. Today, measurement tools often need to be equipped with artificial intelligence and give sophisticated information about the object. Human wisdom gives intelligence to the tool, and more advanced knowledge is gained by human use of that tool.

Above except reproduced from the exposition guide book.

OIML CERTIFICATES registered from March 1994 to June 1994

CERTIFICATS OIML enregistrés de mars 1994 à juin 1994

HOW TO USE THE LIST OF OIML CERTIFICATES
COMMENT UTILISER LA LISTE DES CERTIFICATS OIML



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

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

- **R 76/1992-DE-94.01**
  Gottl. Haigis GmbH
  Schwabstraße 70/72, D 72461
  Albstadt, Germany
  Series HW (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-94.01**
  Société Lutrana
  50, avenue du Président Kennedy
  91170 Viry Châtillon (France)
  Balance Lutrana modèle EL 25 (Class II)

- **R 76/1992-FR-94.02**
  Campesa S.A.
  Avda. Can Sucarrats, s/n Poligono Ind. Cova Solera Apartado 128
  08191 Rubi (Barcelona) - Spain
  Balance DINA modèle GC (Classe III

The following recommendations are applicable within the OIML Certificate System: R 60 (1991), R 76 (1992), R 97 (1990), R 98 (1991), R 110 (being printed), R 112 (1994), R 113 (1994). Issuing authorities for certain of these categories now exist in the following countries *(ISO country codes)*: BE, BG, CH, CN, DE, DK, ES, FR, GB, HU, NL, NO, RO, RU, SE and US.

OIML CERTIFICATION CONTRIBUTES TO ENVIRONMENTAL PROTECTION

Two new OIML Recommendations relative to chromatographic systems for measuring pesticides and toxic substances (R 112) and hazardous chemical pollutants (R 113) have just been published and are immediately applicable within the OIML Certificate System.

Even if regulations concerning the protection of the environment already exist in many countries, chromatographs are rarely subject to legal controls according to the present situation. Therefore, the principal aim of OIML certification is not to facilitate the national type approvals of these instruments. Instead, it permits those bodies responsible for protecting the environment to be equipped with adequate measuring instruments and to use them in an efficient manner.

The accuracy of this type of instrument depends largely on the possibility of calibrating them, before and after a series of measurements, with the use of reference materials that have characteristics similar to those of the pollutants to be detected and measured.

Of course, the OIML certification of the chromatographs covered in R 112 and R 113 does not claim to prevent the use of other measuring techniques, certain of which will be covered by future OIML Recommendations. ■

LA CERTIFICATION OIML CONTRIBUE A LA PROTECTION DE L'ENVIRONNEMENT

Deux nouvelles Recommandations OIML relatives à des systèmes chromatographiques pour la mesure des pesticides et substances toxiques (R 112) et des polluants chimiques dangereux sur site (R 113) viennent d'être publiées et sont immédiatement applicables au système de certification OIML. Une liste des pays ayant établi des autorités de délivrance de certificats OIML pour ces deux types d'instruments sera publiée ultérieurement dans le Bulletin OIML.

Même si, dans beaucoup de pays, des réglementations existent sur la protection de l'environnement, les chromatographes sont actuellement rarement soumis aux contrôles légaux. La certification OIML ne vise donc pas, essentiellement, à faciliter les approbations de modèles nationales de ces instruments, mais à permettre aux organismes de protection de l'environnement de s'équiper d'instruments de mesure adéquats et de les utiliser de façon appropriée.

En effet, l'exactitude de ce type d'instrument dépend beaucoup de la possibilité de les étalonner, avant et après une série de mesures, avec des matériaux de référence présentant des caractéristiques proches de celles des polluants que l'on veut détecter et mesurer.

La certification OIML des chromatographes objets des R 112 et 113 ne prétend bien sûr pas empêcher l'utilisation d'autres techniques de mesure, dont certaines feront l'objet de futures Recommandations OIML. ■

NEW PUBLICATIONS / *NOUVELLES PUBLICATIONS*

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

R 111 Weights of accuracy classes E_1, E_2, F_1, F_2, M_1, M_2, M_3
Poids des classes de précision E_1, E_2, F_1, F_2, M_1, M_2, M_3

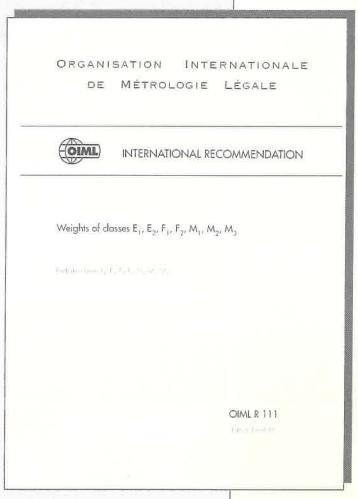
R 112 High performance liquid chromatographs for measurement of pesticides and other toxic substances
Chromatographes en phase liquide de haute performance pour la mesure des pesticides et autres substances toxiques

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

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

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

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



meetings

OIML

réunions

October 1994

10–11	Development Council Meeting	PARIS
12–14	29th CIML Meeting	PARIS

November 1994

12	TC 13 Measuring instruments for acoustics and vibration	LONDON

December 1994

Date not fixed	TC 9/SC 2 Automatic weighing instruments	TEDDINGTON

ISO

September 1994

12, 17	ISO/TC 176 Quality management and quality assurance	TORONTO

Contact information:
K.C. Ford, Secretary of ISO/TC 176
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19, 22	ISO/TC 69/SC 6 Application of statistical methods / Measurement methods and results	TOKYO

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19, 23	ISO/TC 69/SC 5 Application of statistical methods / Acceptance sampling	TOKYO

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OTHER MEETINGS

October 1994

4	Quality Systems in NAMAS Laboratories Seminar, Leatherhead, UK	LEATHERHEAD (UK)

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IMEKO

XIII IMEKO WORLD CONGRESS
International Measurement Confederation

FROM MEASUREMENT TO INNOVATION

September 5–9, 1994
Lingotto Centro Congressi
Torino (Italy)

INVITED LECTURERS

Prof. Dr. T. J. Quinn
Director of Bureau International des Poids et Mesures, Sèvres (France)
Metrology, its role in today's world

Prof. L. Finkelstein
City University, London
Measurement information and knowledge, fundamental concepts, philosophical aspects and applications

Dr Ing. G. Levizzari
Centro Ricerche FIAT, Torino
The role of measurement in the vehicle development process

ROUND TABLES

TC 1 *Coupling of measurands to sensors* • TC 3 *Problems of force measurement and weighing under non-static conditions* • TC 7 *Challenges, visions and tasks for IMEKO activity in TC 1 (Education and Training) and TC 7 (Measurement Science)* • TC 8 *Traceability of electrical standards of national laboratories* • TC 10 *The role of human beings in technical diagnostic* • TC 11 *Metrological requirements for quality assurance in developing countries* • TC 11 *Problems concerned with the build-up of metrological infrastructures* • TC 13 *New trends in biomedical measurement technology* • TC 13 *Measurements and computer simulations in proton therapy* • TC 15 *Relation and Interaction between Measurement, Experiments and Numerical Analysis in Solid Mechanics* • TC 17 *Robots: a developing species*

Registration for this Congress is encouraged before August 15, 1994. After that date, participants may register and pay on the opening day of the Congress.

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PUBLICATIONS

classified by subject

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

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

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

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

Ces publications peuvent être commandées(**) par lettre ou fax au BIML (voir adresse plus haut).

I GENERAL
GÉNÉRALITÉS

R 34 1979 - 1974 — 60 FRF
Accuracy classes of measuring instruments
Classes de précision des instruments de mesurage

R 42 1981 - 1977 — 50 FRF
Metal stamps for verification officers
Poinçons de métal pour Agents de vérification

D 1 1975 — 50 FRF
Law on metrology
Loi de métrologie

D 2 (in revision - en cours de révision)
Legal units of measurement
Unités de mesure légales

D 3 1979 — 60 FRF
Legal qualification of measuring instruments
Qualification légale des instruments de mesurage

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

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

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

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

D 14 1989 — 60 FRF
Training of legal metrology personnel - Qualification - Training programmes
Formation du personnel en métrologie légale - Qualification - Programmes d'étude

D 15 1986 — 80 FRF
Principles of selection of characteristics for the examination of measuring instruments
Principes du choix des caractéristiques pour l'examen des instruments de mesure usuels

D 16 1986 — 80 FRF
Principles of assurance of metrological control
Principes d'assurance du contrôle métrologique

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

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

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

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

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

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

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

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

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

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

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

II MEASUREMENT STANDARDS AND VERIFICATION EQUIPMENT
ÉTALONS ET EQUIPEMENT DE VERIFICATION

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

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

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

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

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

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

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

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

P 15 1989 100 FRF
Guide to calibration

III MASS AND DENSITY
MASSES ET MASSES VOLUMIQUES

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

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

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

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

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

R 50 1994 100 FRF
Continuous totalizing automatic weighing instruments
Instruments de pesage totalisateurs continus à fonctionnement automatique

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

R 52 1980 50 FRF
Hexagonal weights, ordinary accuracy class from 100 g to 50 kg
Poids hexagonaux de classe de précision ordinaire, de 100 g à 50 kg

R 60 1991 80 FRF
Metrological regulation for load cells
Réglementation métrologique des cellules de pesée
1993 80 FRF
Annex A: Test report format for the evaluation of load cells
Annexe A: Format du rapport d'essai des cellules de pesée

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

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

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

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

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

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

R 111 1994 80 FRF
Weights of accuracy classes E_1, E_2, F_1, F_2, M_1, M_2, M_3
Poids des classes de précision E_1, E_2, F_1, F_2, M_1, M_2, M_3

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

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

IV LENGTH AND SPEED
LONGUEURS ET VITESSES

R 21 1975 - 1973 60 FRF
Taximeters
Taximètres

R 24 1975 - 1973 50 FRF
Standard one metre bar for verification officers
Mètre étalon rigide pour Agents de vérification

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

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

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

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

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

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

V LIQUID MEASUREMENT
MESURAGE DES LIQUIDES

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

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

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

R 29 1979 - 1973 50 FRF
Capacity serving measures
Mesures de capacité de service

R 40 1981 - 1977 60 FRF
Standard graduated pipettes for verification officers
Pipettes graduées étalons pour Agents de vérification

R 41 1981 - 1977 60 FRF
Standard burettes for verification officers
Burettes étalons pour Agents de vérification

R 43 1981 - 1977 60 FRF
Standard graduated glass flasks for verification officers
Fioles étalons graduées en verre pour Agents de vérification

R 45 1980 - 1977 50 FRF
Casks and barrels
Tonneaux et futailles

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

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

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

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

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

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

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

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

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

R 85 1989 80 FRF
Automatic level gauges for measuring the level of liquid in fixed storage tanks
Jaugeurs automatiques pour le mesurage des niveaux de liquide dans les réservoirs de stockage fixes

R 86 1989 50 FRF
Drum meters for alcohol and their supplementary devices
Compteurs à tambour pour alcool et leurs dispositifs complémentaires

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

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

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

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

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

VI GAS MEASUREMENT
MESURAGE DES GAZ

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

R 31 1989 80 FRF
Diaphragm gas meters
Compteurs de volume de gaz à parois déformables

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

VII PRESSURE
PRESSIONS(*)

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

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

R 97 1990 60 FRF
Barometers
Baromètres

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

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

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

R 110 (being printed - en cours de publication)
Pressure balances
Manomètres à piston

VIII TEMPERATURE
TEMPÉRATURES(*)

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

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

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

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

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

IX ELECTRICITY
ÉLECTRICITÉ

R 46 1980 - 1978 80 FRF
Active electrical energy meters for direct connection of class 2
Compteurs d'énergie électrique active à branchement direct de la classe 2

D 11 (in revision - en cours de révision)
General requirements for electronic measuring instruments
Exigences générales pour les instruments de mesure électroniques

X ACOUSTICS AND VIBRATION
ACCOUSTIQUE ET VIBRATIONS

R 58 1984 50 FRF
Sound level meters
Sonomètres

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

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

R 102 1992 50 FRF
Sound calibrators
Calibreurs acoustiques

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

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

XI ENVIRONMENT
ENVIRONNEMENT

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

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

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

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

R 112 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

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

XII PHYSICO-CHEMICAL MEASUREMENTS
MESURES PHYSICO-CHIMIQUES

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

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

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

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

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

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

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

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

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

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

D 17 1987 50 FRF
Hierarchy scheme for instruments measuring the viscosity of liquids
Schéma de hiérarchie des instruments de mesure de la viscosité des liquides

XIII MEDICAL INSTRUMENTS
INSTRUMENTS MÉDICAUX

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

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

R 26 1978 - 1973 50 FRF
Medical syringes
Seringues médicales

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

R 89 1990 80 FRF
Electroencephalographs - Metrological characteristics - Methods and equipment for verification
Electroencéphalographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

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

R 93 1990 60 FRF
Focimeters
Frontofocomètres

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

XIV TESTING OF MATERIALS
ESSAIS DES MATÉRIAUX

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

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

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

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

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

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

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

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

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

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

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

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

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

P 11 1983 100 FRF
Factors influencing hardness measurement

P 12 1984 100 FRF
Hardness test blocks and indenters

P 13 1989 100 FRF
Hardness standard equipment

P 14 1991 100 FRF
The unification of hardness measurement

XV PREPACKAGING
PRÉEMBALLAGES

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

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

OIML BULLETIN

CALL FOR PAPERS

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

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

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

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