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## Automatic weighing instruments: an increasing demand in a fast-paced world

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# NOTE on the FIRST MEETING
# of the JOINT WORKING GROUP of the CONVENTION DU MÈTRE and the OIML

**held at the Pavillon de Breteuil**
**on 22 February 1996**

The first meeting of the joint working group of the Convention du Mètre and the OIML foreseen in Resolution 10 of the 20th CGPM took place on 22 February 1996. At the invitation of the President of the CIPM, the meeting was held at the Pavillon de Breteuil. Present were:

*Convention du Mètre:* D. Kind (President of the CIPM), J. Kovalevsky (Secretary of the CIPM), W.R. Blevin (Vice-President of the CIPM), K. Iizuka (Vice-President of the CIPM) and T.J. Quinn (Director of the BIPM)

*OIML:* G. Faber (President of the CIML), S. Chappell (Vice-President of the CIML), M. Kochsiek (Vice-President of the CIML), J. Birch (Member of the Presidential Council of the CIML), and B. Athané (Director of the BIML).

The working group reviewed the events that took place in 1995 leading up to the adoption by the 20th Conférence Générale of Resolution 10, on future relations between the two organizations, and to the adoption of a parallel Resolution by the International Committee of Legal Metrology, during its 30th meeting. It was agreed that these relations should be considered in the context of the future needs of metrology. Most of the discussion was devoted to identification of these future needs. It was recognized that an important contribution will be the results of a study now being undertaken by the CIPM on the future needs of metrology, following Resolution 11 of the 20th Conférence Générale. These will be considered with the content of the long-term policy document of the OIML, published in 1995. It is expected that a draft of the CIPM study will be ready for presentation to the CIPM in September 1996 after being reviewed by the OIML and other interested parties during the Summer. A second meeting of the joint working group will take place in September 1996, after the CIPM meeting but before the OIML Conférence Générale, and a third in February 1997. At the third meeting, other international organizations will be invited to participate. The Directors of the BIPM and the BIML were asked to explore the possibility of developing a closer relationship in certain of their activities and to report back at the September meeting.

B. ATHANÉ
BIML Director

T.J. QUINN
BIPM Director

# NOTE sur la PREMIÈRE RÉUNION du GROUPE de TRAVAIL COMMUN de la CONVENTION du MÈTRE et de L'OIML

**qui s'est tenue au Pavillon de Breteuil**
**le 22 février 1996**

La première réunion du groupe de travail commun de la Convention du Mètre et de l'OIML envisagé dans la Résolution 10 de la 20$^{e}$ CGPM s'est tenue le 22 février 1996. A l'invitation du Président du CIPM le Groupe de travail s'est réuni au Pavillon de Breteuil. Etaient présents:

*Convention du Mètre:* D. Kind (Président du CIPM), J. Kovalevsky (Secrétaire du CIPM),
W.R. Blevin (Vice-Président du CIPM), K. Iizuka (Vice-Président du CIPM)
et T.J. Quinn (Directeur du BIPM)

*OIML:* G. Faber (Président du CIML), S. Chappell (Vice-Président du CIML),
M. Kochsiek (Vice-Président du CIML), J. Birch (Membre du Conseil de Présidence du CIML)
et B. Athané (Directeur du BIML).

Le groupe de travail a rappelé les événements qui se sont déroulés en 1995 et qui ont conduit à l'adoption par la 20$^{e}$ Conférence Générale de la Résolution 10 sur les relations futures entre les deux organisations, ainsi qu'à l'adoption d'une Résolution parallèle par le Comité International de Métrologie Légale, lors de sa 30$^{e}$ réunion. Tout le monde a été d'accord pour dire que ces relations doivent être envisagées dans la perspective des besoins futurs de la métrologie. L'essentiel des discussions a donc porté sur l'identification de ces besoins futurs. A l'évidence, les résultats d'une étude sur les besoins à long terme de la métrologie, actuellement entreprise par le CIPM conformément à la demande de la 20$^{e}$ CGPM exprimée dans sa Résolution 11, constitueront une contribution importante. Ils devront être étudiés en même temps que le contenu du document de l'OIML sur la politique à long terme, publié en 1995. Un projet de cette étude faite par le CIPM devrait être présenté au CIPM en septembre 1996, après avoir été soumis dans le courant de l'été à l'OIML et aux autres parties intéressées. Une seconde réunion du groupe de travail commun aura lieu au mois de septembre 1996, après la session du CIPM mais avant la Conférence générale de l'OIML; une troisième réunion est prévue au mois de février 1997. D'autres organisations internationales seront invitées à participer à cette troisième réunion. Il a été demandé aux directeurs du BIPM et du BIML d'explorer la possibilité de développer des relations plus étroites pour certaines de leurs activités et d'en rendre compte à la réunion du mois de septembre 1996.

B. ATHANÉ
Directeur du BIML

T.J. QUINN
Directeur du BIPM

# OIML BULLETIN

VOLUME XXXVII • NUMBER 2 • APRIL 1996

## technique



## evolutions



## update



AUTOMATIC WEIGHING INSTALLATIONS

THE BULLETIN PRESENTS A SERIES OF ARTICLES ON REGULATIONS AND TECHNICAL APPROACHES.

*Courtesy of Central Weighing, Philips, and Railweight*

# OIML BULLETIN

VOLUME XXXVII • NUMÉRO 2 • AVRIL 1996

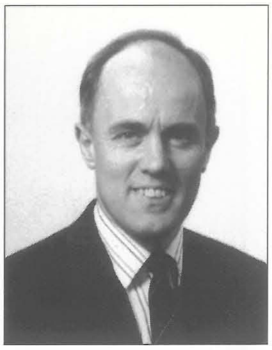

## technique



## évolutions



## d'un bulletin à l'autre



# Editorial

I AM delighted and honoured to have been asked to write an Editorial on the importance of weighing for this issue of the OIML Bulletin, which contains four of the excellent papers presented at last September's OIML seminar "Weighing towards the year 2000". The seminar reflected the latest developments in weighing and demonstrated clearly the need for international metrological specifications in those applications where legal control is required to protect the consumer and maintain confidence in trade.

Readers of the Bulletin will hardly need to be reminded how important weighing is in our everyday lives. It seems to me that the direct economic value that can be ascribed to weighing may be greater than that associated with any other type of measurement. Whether you are shopping for food, visiting your doctor, sending a package by post or checking in your luggage for an international flight, you will depend on accurate reliable weighing equipment to protect your health, your safety and your wallet.

In the UK alone it is probably the case that at least half a billion pounds worth of goods are weighed at the retail level each week. In the industrial sector too we find weighing equipment in widespread use for wholesale trade, for process control and for production monitoring. Two of the papers in this issue of the Bulletin deal with weighing in motion - the heavyweight division - where reliability and stability are tested to the full in what are often the most demanding environments.

The importance of weighing in today's world and the variety of different types of weighing instruments used are reflected in the fact that, since the publication of the OIML Recommendation (R 76) on nonautomatic weighing instruments in 1992, no fewer than five further Recommendations on weighing instruments have been completed. Taken together, these provide a set of harmonised regulations which will form the basis for the legal control of weighing around the world towards the year 2000.

With the development of the OIML Certificate System and the preparation of regional agreements on mutual recognition, such as the Canada/USA agreement and the WELMEC agreement, manufacturers will increasingly be able to produce weighing instruments for a global market, confident that they will not encounter technical barriers to trade erected in the name of legal metrology. ■

Seton Bennett

**Seton Bennett**
**Chairman, OIML seminar**
**"Weighing towards the year 2000"**

DURABILITY ANALYSIS

# Zero and calibration stability on beltweighers

## A comparison of two beltweighers weighing the same product

OIML Seminar
WEIGHING TOWARDS THE YEAR 2000
13–15 September 1995 Maison de la Mécanique, Paris

**P. W. CHASE,** Chase Technology Inc., United States of America

This is a story of two beltweighers, A and B. The same stream of coal passes over both A and B at a rate ranging from 640 t/h (700 US tons/h) to 940 t/h (1 034 US tons/h). Both beltweighers are approved and sealed by a State regulatory agency. Beltweigher A is approved under the US regulation (Handbook 44 - *see Appendix A, pp. 11–13*) in force at the time it was installed. Beltweigher B is installed to meet the newer NTEP (National Type Evaluation Program) requirements. NTEP requirements are essentially equivalent to OIML R 50. According to the scale manufacturer, the components of A and B are of the same quality; the only differences in the two installations are found in the conveyor.

These beltweighers are used as a basis of payment for coal transported continuously from the mine to the electric utility. A third party monitors the performance of the beltweighers and the control instrument. The control instrument is a weigh bin with a capacity of 218 tonnes (240 US tons). This weigh bin is tested every six months immediately prior to its use for calibration of the beltweighers. This weigh bin is also used each week to test the performance of the beltweighers. The conveyors on which the two beltweighers are installed are quite different from one another. The following table lists some of the conveyor belt parameters.

In 1991, the third party monitoring the weighing systems began a program to improve the weighing. Both beltweighers performed adequately for approval testing, but during weekly tests they differed from one another, and Beltweigher A often differed from the weigh bin by more than the allowable tolerance. (The contractual arrangement between buyer and seller provides an adjustment method for total tonnage based on the beltweigher comparison to the weigh bin.)

Throughout this time, Beltweigher B maintained its tolerance better than did Beltweigher A, but operational considerations make Beltweigher A the preferred unit for measuring the shipped quantity of coal.

Because A had the greater variability, in June 1991 a personal computer was connected to the beltweigher integrator to monitor the changes resulting from auto zeroing of the beltweigher. The beltweigher electronics uses a stored digital value to represent zero, the no-load condition of the conveyor belt. Each time that number changes, the monitoring computer stores the new value together with the date and time at which the change occurred.

In a perfect world, or at least an improved experiment, Beltweigher B would be similarly monitored - it is not. But in a perfect world the beltweigher would always weigh correctly, so this discussion would not be necessary. It is obvious and well accepted that a beltweigher must have a reliable zero if it is to provide accurate weighing. Beltweigher A demonstrated frequent, and quite large, changes in zero. For example, Fig. 1 shows the change in zero number and the zero change as percent of full scale for July 1991. The scale electronics for Beltweighers A and B has been modified so that only auto zeroing occurs; it is not possible to initiate a manual zeroing procedure.

Some of the zero changes were sufficiently large that the limit on zero adjustment in the beltweigher electronics was reached quite regularly. With the agreement of the regulatory agency, the limitation was removed to

**Table 1 Conveyor belt parameters.**

| | Beltweigher A | Beltweigher B |
|---|---|---|
| Conveyor belt length (unwound length) | 36 m (117 ft) | 143 m (468 ft) |
| Head to Tail C-C | 16.8 m (55 ft) | 65 m (214 ft) |
| Belt width | 1 200 mm (48 in) | 1 100 mm (42 in) |
| Belt thickness | 16 mm (0.625 in) | 12 mm (0.5 in) |
| Belt speed | 2.4 m/s (473 ft/min) | 3.2 m/s (620 ft/min) |
| Tare weight of belt | 21.7 kg/m (14.6 lbs/ft) | 16.4 kg/m (11 lbs/ft) |
| Weigh span | 3.65 m (12 ft) | 3.65 (12 ft) |
| Belt loading | 115 kg/m (77 lbs/ft) | 82.6 kg/m (55.5 lbs/ft) |
| Angle of incline | 6.5 degrees | 15 degrees |
| Distance from load point to beltweigher | 6.7 m (22 ft) | 7.9 m (26 ft) |
| Distance from end of skirting to beltweigher | 4 idlers | 5 idlers |
| Distance from beltweigher to head pulley | 5.3 m (17.5 ft) | 46.6 m (153 ft) |
| Troughing angle | 35 degrees | 35 degrees |

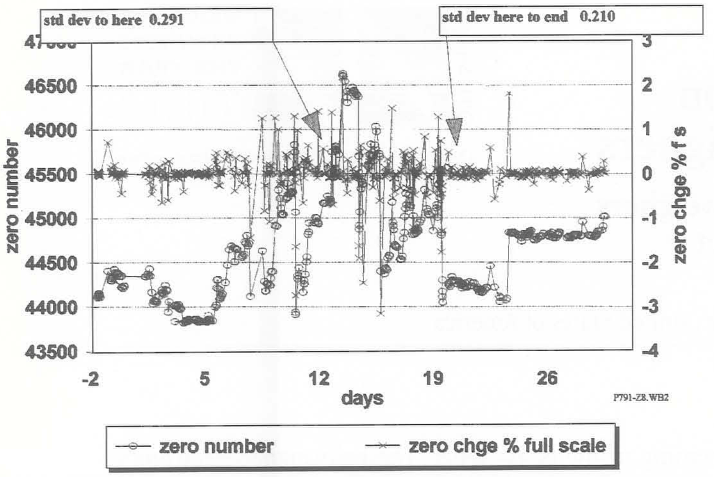



Fig. 1 Beltweigher A: Zero number and zero change (percent of full scale) for July 1991.

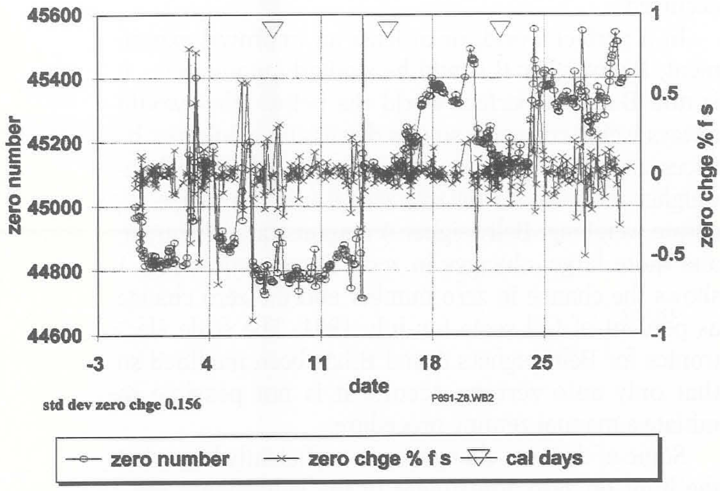



Fig. 2 Beltweigher A: Zero number and zero change (percent of full scale) for August 1991.

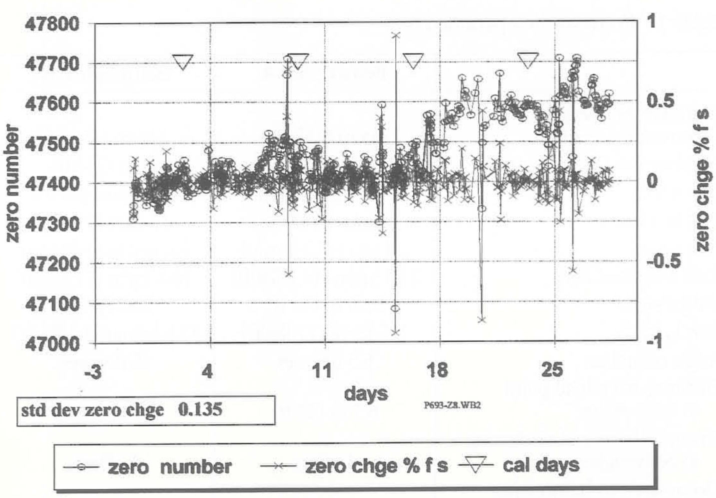



Fig. 3 Beltweigher A: Zero number and zero change (percent of full scale) for June 1993.

allow a large adjustment of zero using the automatic zeroing of the beltweigher. Actually, this limitation was removed before the monitoring began in June 1991. The logic involved was that less error will be introduced by allowing the unit to re-zero over a larger range than by deliberately introducing a zero error by limiting the range. Further discussion will show that the zero excursions are greatly reduced after considerable work on the conveyor and the beltweigher installation.

With the zero number monitoring system in place, work was begun to reduce the variability of Beltweigher A. An initial modification to the beltweigher was the addition of angled plastic covers on the horizontal portions of the beltweigher to reduce dust buildup. This modification was completed on 10 August 1991, and was physically observed to nearly eliminate dust buildup. However, the changes in zero persisted, as seen in Fig. 2 (August 1991). The dust covers were further improved in May 1993, and Fig. 3 for June of 1993 shows that the zero changes are still similar in character.

As seen in the figures, the changes in zero occur over a short time period. Figure 4 shows the zero changes during August 1991 as the equivalent change in kg/h. Dust buildup would be expected to occur more slowly although it could be quickly removed by cleaning the scale. The improvements in zero, which must be present from the elimination of dust buildup, are apparently masked by the other zero changes.

In January 1994, Beltweigher A was mechanically realigned. Figure 5 for March 1994 shows a narrower range of zero variation than previous figures (see Fig. 3 - June 1993 for example). The changes are still rapid. Figure 6 for March 1994 is a plot of zero change versus the time in days since the previous change. Surprisingly, the magnitude of the zero adjustment is independent of the time interval between adjustments for periods from about 1 hour to periods of about 7 hours. Beyond 7 hours there are too few observations to be significant. Figure 7 shows similar information; the variations within each day are plotted on a single line representing that day along the X axis.

Temperature is known to affect belt stiffness and therefore, the effects of temperature were considered. Figures 8 and 9 plot the zero number and temperature for Beltweighers A and B by days from January through September 1994. Figures 10 and 11 plot zero number against temperature over this same time period for both Beltweighers A and B. Beltweigher B does have a trend, but the correlation coefficient is quite low.

The gravity tensioning device was considered a possible cause of zero changes and was carefully examined to ensure that all pulleys and cables were free. This is a pulley type gravity takeup. The tail pulley for the conveyor is supported on a rail with tension applied through cables which support the tensioning mass. This arrangement has several carriage wheels and cable pulleys which require regular lubrication. It also requires inspection to see that the rails are not blocked. A regular lubrication and inspection regime was established. The rapid zero changes persisted, but over a narrower range.

Conveyor belt tracking was identified as a possible source of the rapid zero changes, and belt training idlers on the return side of the conveyor were carefully adjusted to reduce side travel to a minimum. This change also resulted in a reduced range of zero changes.

In March 1995, the beltweigher manufacturer was contracted to thoroughly refurbish the entire installation. Where the conveyor structure has been weakened, additional stiffening was added by cutting out a portion of the conveyor assembly. The manufacturer carefully realigned the beltweigher to the conveyor belt to compensate for any shifting of the conveyor structure having occurred since the initial installation.

On March 27 and 28, the weigh bin and the beltweighers were tested by the State Weights and Measures officials.

Figure 12 shows the zero data since the testing in March 1995. The zero stability is significantly improved from the data of 1991 and is improved from the data of March 1994 when previous alignment was completed. In March 1994, the standard deviation of zero change was 0.091 and the figure for April 1995 shows a standard deviation of 0.059. Figure 13 for April 1995 is similar to Fig. 6 for March 1994, showing that the magnitude of zero adjustment is independent of the time since the previous zero adjustment.

And what about Beltweigher B? That beltweigher was installed to NTEP requirements. First of all, the detailed information on automatic zeroing is not available; this beltweigher is not connected to the data-gathering computer. Figures 8 and 10 contain zero information from 3 pm over an appreciable time period, but do not contain the continuous data of Beltweigher A. The other information available for Beltweigher B comprises the weekly "correction" data. Figure 14 shows the correction data from January 1992 through October 1994. Throughout the period, Beltweigher B is a more well-behaved unit than Beltweigher A. There are a few excursions beyond 0.5 percent, but not nearly so many as for Beltweigher A.

A beltweigher approved under NTEP must meet a permanence test. This requires that the beltweigher, as initially installed, must meet the tolerance requirements after six months. Zero adjustment, either manual or automatic, is allowed. Beltweigher B has met this requirement, and has remained sealed for more than one year.

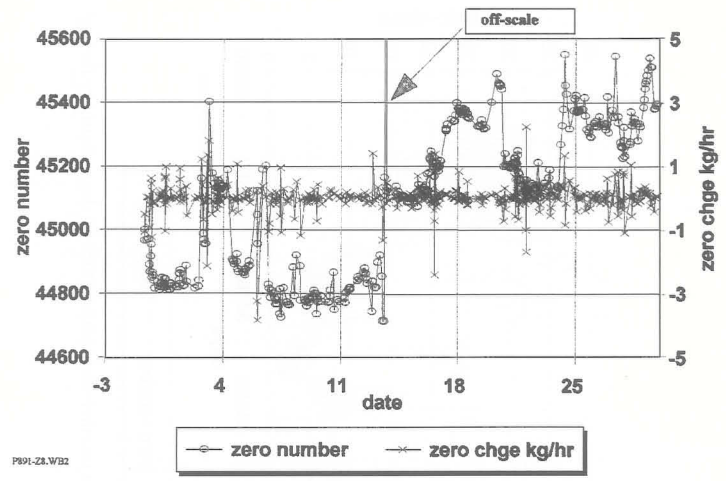



Fig. 4 Beltweigher A: Zero number and zero change (kg/h) forAugust 1991.

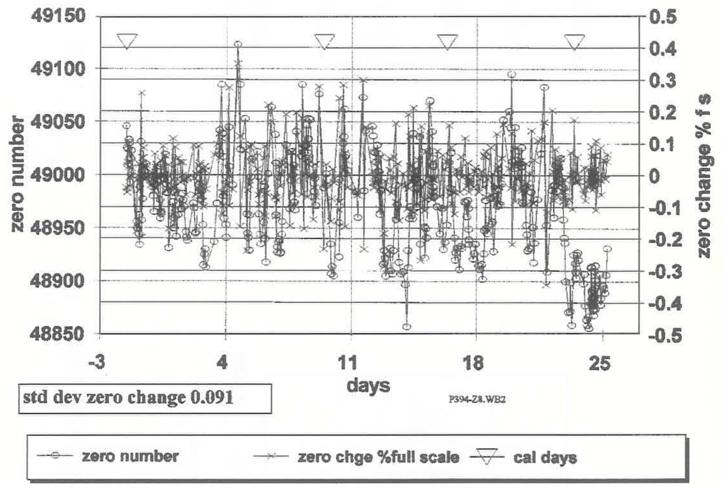



Fig. 5 Beltweigher A: Zero number and zero change (percent of full scale) for March 1994.

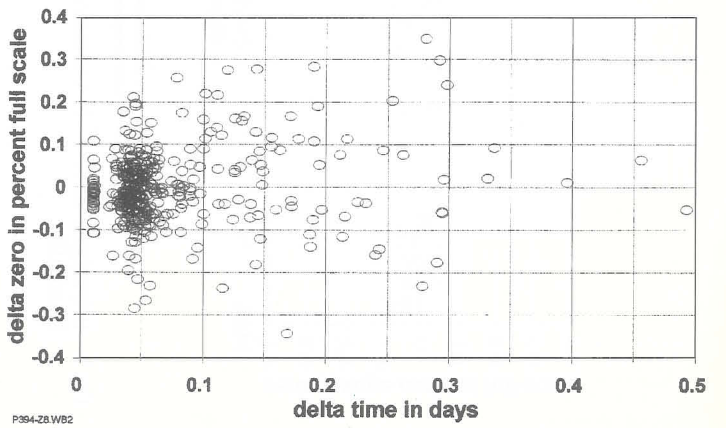



Fig. 6 Beltweigher A: Zero change (percent of full scale) versus change in time (in days) for March 1994.

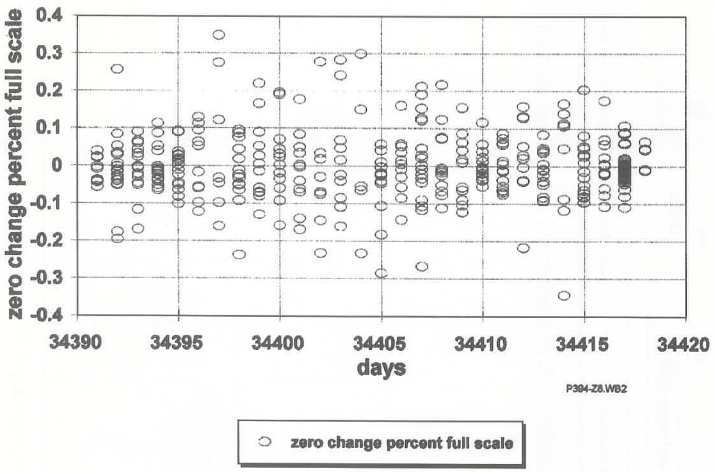



Fig. 7 Beltweigher A: Zero change (percent of full scale) during days for March 1994.

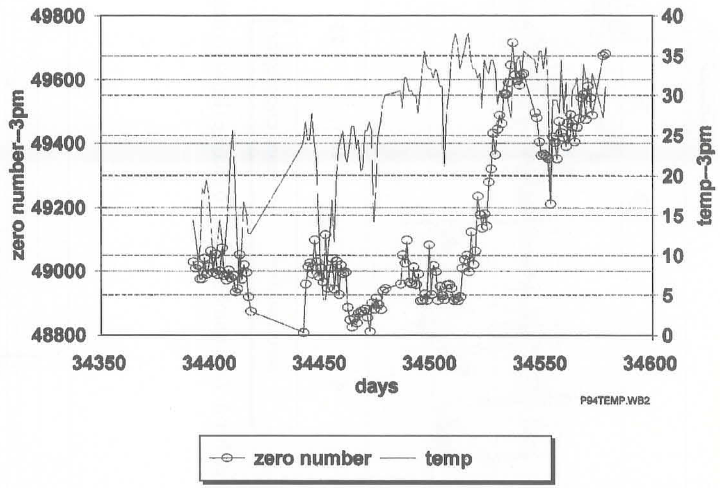



Fig. 8 Beltweigher A: Zero number and temperature by days - January through September 1994.

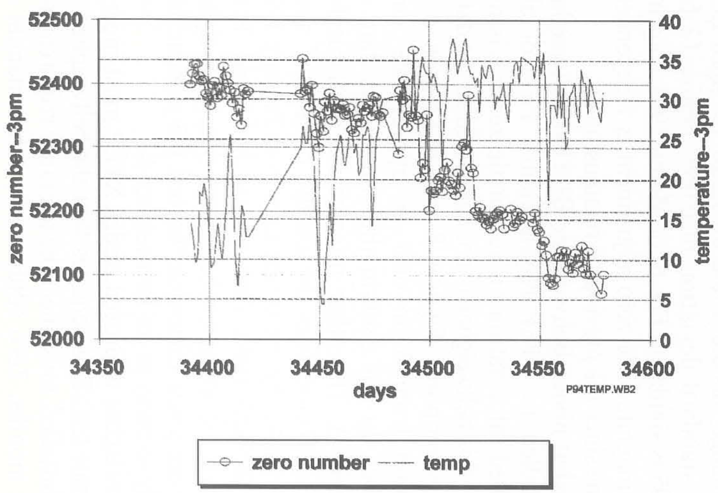



Fig. 9 Beltweigher B: Zero number and temperature by days - January through September 1994.

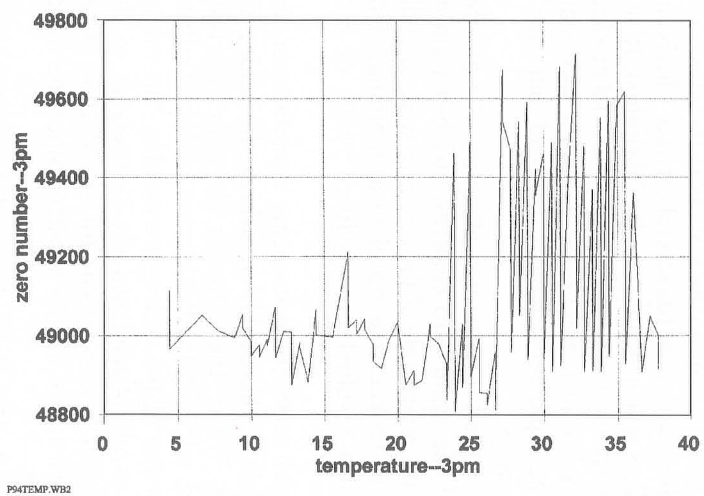



Fig. 10 Beltweigher A: Zero number versus temperature for January through September 1994.

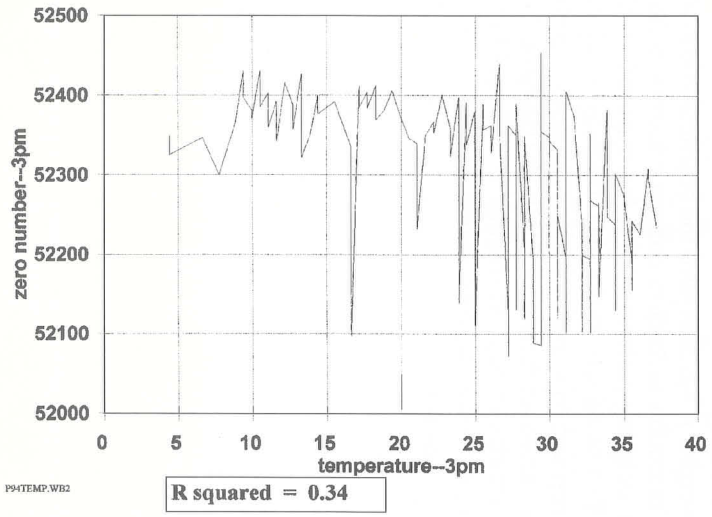



Fig. 11 Beltweigher B: Zero number versus temperature for January through September 1994.

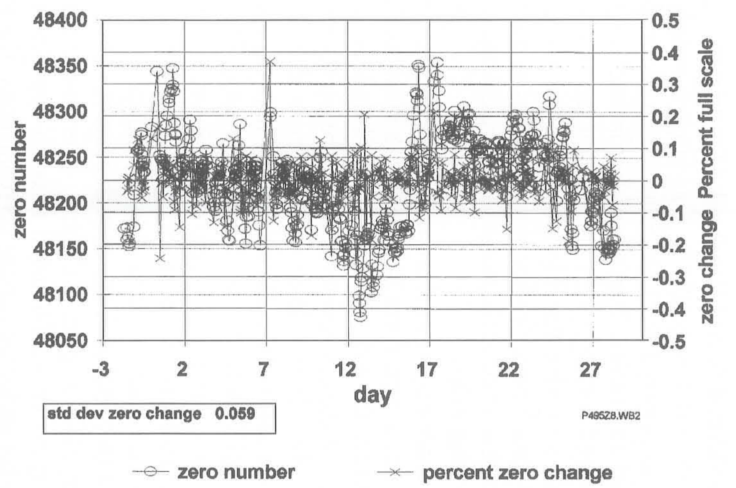



Fig. 12 Beltweigher B: Zero number and zero change (percent of full scale) for April 1995.

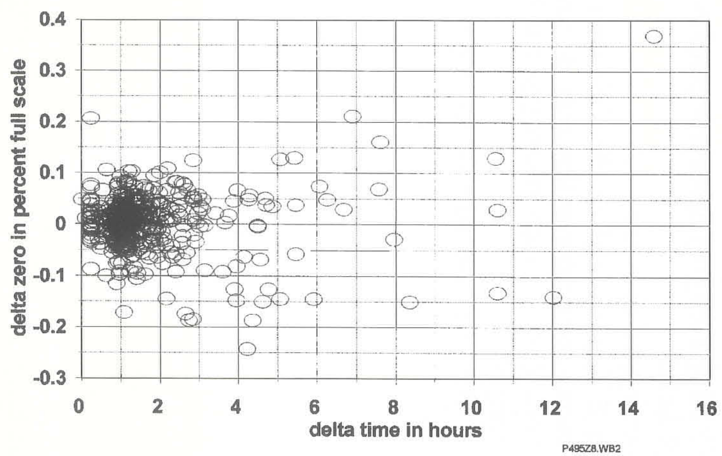



Fig. 13 Beltweigher A: Zero change versus change in time (in hours) for April 1995.

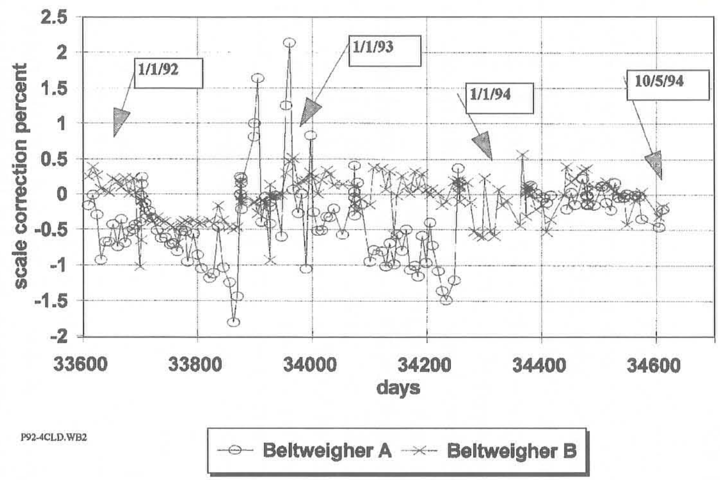



Fig. 14 Scale compared to control instrument - January 1992 through September 1994.

## Conclusions

Beltweigher A has been subjected to especially close scrutiny over the past four years. That scrutiny began because the beltweigher performed poorly. The current performance is within required tolerance for an approved conveyor scale in NIST Handbook 44 or for a class 0.5 beltweigher in OIML R 50. It is too early to know whether the beltweigher will remain in tolerance over a six-month to one-year period.

Although Beltweigher A fulfills the simulation tests of section 2.5 of OIML R 50 and the similar requirements of NTEP, it does not completely meet the installation requirements of NTEP and OIML. This illustrates the need for some of the requirements of those regulations, infers that some additional requirements could be useful, and perhaps questions the need for some existing requirements.

Appendix A *(pp. 11–13)* is a photocopy of the user requirements for conveyor scales (beltweighers) as contained in NIST Handbook 44.

OIML R 50 sections 3.7 and 3.8 contain requirements and recommendations for the installation of a beltweigher. These sections are not as explicit as those contained in Handbook 44, but are similarly intended to provide a beltweigher installation capable of weighing within the specified tolerance.

The following characteristics of the installed Beltweigher A either implicitly or explicitly differ from the requirements of NTEP and OIML.

1. The belt loading is relatively light as compared to the weight of the belt.
2. The conveyor belt is quite heavy.
3. Although 35 degree troughing idlers are not prohibited, on this short conveyor they make the whole system more sensitive to any misalignment or belt tracking variation.
4. The fifth idler after the skirtboards is the first weighing idler.

Both OIML R 50 and Handbook 44 restrict the range of zero to a total range of 4 %. This range is usually set at plus or minus 2 % of the value when the scale is approved and sealed. Because of factors such as zero buildup and conveyor belt top cover wear, it may be desirable to widen the allowable range of zero. Additional data from a number of installations would help to determine whether the range should be changed, and if so, to what value.

The examination of thousands of data points over several years' time from Beltweigher A illustrates that the nature of the zero performance of a beltweigher can be observed directly given the proper beltweigher electronics. The direct observation of zero allows the stability of zero to be confirmed, rather than depending on the fulfillment of the installation guidelines to provide an assumption of zero acceptability. Although such capability is not required by NTEP or OIML, the value of such data is illustrated by these data.

Since Beltweigher A has enough characteristics that are marginal for good weighing, it is doubtful that a manufacturer would install it as an approval type beltweigher under the current US regulations. The third party monitor has tenaciously pursued improvement in the weighing performance of Beltweigher A with the cooperation of the conveyor system owner who is responsible for the operating and maintenance personnel. As a result of these efforts, the zero is currently quite stable and Beltweigher A has remained within tolerance for the several weeks following the March 27 testing.

Beltweigher A has illustrated the beneficial effects of careful attention to various conveyor factors in improving weighing performance. It has required much more effort to achieve reasonable weighing accuracy than is required on a conveyor which conforms entirely with the recommendations of OIML or Handbook 44. And it remains to be seen whether it will fulfill the permanence test-remaining within tolerance for a period of six months. ■

## APPENDIX A

2.21. Belt-Conveyor Scale Systems

**N.3.3. Simulated Load Tests. -**

(a) As required by the official with statutory authority, simulated load tests as recommended by the manufacturer are to be conducted between material tests to monitor the system's operational performance, but shall not be used for official certification.
(Amended 1991)

(b) A simulated load test consisting of at least three consecutive test runs shall be conducted as soon as possible, but not more than 12 hours after the completion of the material test, to establish the factor to relate the results of the simulated load test to the results of the material tests.
(Added 1990)

(c) The results of the simulated load test shall repeat within 0.1 percent.
(Added 1990)

(Amended 1989 and 1990)

### T. Tolerances

**T.1. Tolerance Values[1].** - Maintenance and acceptance tolerances on materials tests, relative to the weight of the material, shall be ± 0.25 percent of the test load.
(Amended 1993)

**T.2. Tolerance Values, Repeatability Tests.** - The variation in the values obtained during the conduct of materials tests shall not be greater than 0.25 percent (1/400).

**T.3. Influence Factors.** - The following factors are applicable to tests conducted under controlled conditions only, provided that:

(a) types of devices approved prior to January 1, 1986, and manufactured prior to January 1, 1988, need not meet the requirements of this Section; and

(b) new types of devices submitted for approval after January 1, 1986, shall comply with the requirements of the Section; and

(c) all devices manufactured after January 1, 1988, shall comply with the requirements of this Section.

**T.3.1. Temperature.** - Devices shall satisfy the tolerance requirements at temperatures of from -10 to 40 °C (14 to 104 °F).

**T.3.1.1. Effect on Zero-Load Balance.** - The zero-load indication shall not change by more than 0.07 percent of the rated capacity of the scale (without the belt) for a change in temperature of 10 °C (18 °F) at a rate not to exceed 5 °C (9 °F) per hour.

*T.3.1.2. Temperature Limits. - If a temperature range other than -10 to 40 °C (14 to 104 °F) is specified for the device, the range shall be at least 30 °C (54 °F).*
*[Nonretroactive as of January 1, 1990]*
(Added 1989)

**T.3.2. Power Supply, Voltage and Frequency.** - A belt-conveyor scale system shall satisfy the tolerance requirements over a range of 100 to 130 V or 200 to 250 V as appropriate and over a frequency range of 59.5 to 60.5 Hz.

### UR. User Requirements

**UR.1. Use Requirements.** - A belt-conveyor scale system shall be operated between 35 and 98 percent of its rated capacity.

**UR.1.1. Minimum Totalized Load.** - Delivered quantities of less than the minimum test load shall not be considered a valid weighment.

**UR.1.2. Security Means.** - When a security means has been broken, it shall be reported to the official with statutory authority.
(Amended 1991)

**UR.2. Installation Requirements.**

**UR.2.1. Protection from Environmental Factors.** - The indicating elements, the lever system or load cells, and the load-receiving element of a belt-conveyor scale shall be adequately protected from environmental factors such as wind, moisture, dust, weather, and

[1] The variables and uncertainties included in the relative tolerance represent only part of the variables that affect the accuracy of the material weighed on belt-conveyor scales. If this tolerance was based on an error analysis beginning with mass standards through all of the test processes and following the principle expressed in Section 3.2. of the Fundamental Considerations in Appendix A, the tolerance would be 0.5 percent.
(Added 1993)

radio frequency interference (RFI) and electromagnetic interference (EMI) that may adversely affect the operation or performance of the device.

**UR.2.2. Conveyor Installation.** - The design and installation of the conveyor leading to and from the belt-conveyor scale is critical with respect to scale performance. The conveyor may be horizontal or inclined, but, if inclined, the angle shall be such that slippage of material along the belt does not occur. Installation shall be in accordance with the scale manufacturer's instructions and the following:

(a) a belt-conveyor scale shall be so installed that neither its performance nor operation will be adversely affected by any characteristic of the foundation, supports, or any other equipment;

(b) all live portions of the scale shall be protected by appropriate guard devices to prevent accidental interference with the weighing operation;

(c) suitable protection shall be provided for storage of any simulated load equipment.

**UR.2.2.1. For Scales not Installed by the Manufacturer.** - Unless the scale is installed in a short conveyor designed and furnished by the scale manufacturer or built to the scale manufacturer's specifications, the conveyor shall comply with the following minimum requirements:

(a) If the belt length is such that a take-up device is required, this device shall be of the counter-weighted type for either vertical or horizontal travel.

(b) The scale shall be so installed that the first weigh idler of the scale is at least 6 m (20 ft) or 5 idler spaces, whichever is greater, from loading point, skirting, head or tail pulley, or convex curve in the conveyor. Any training idler shall be located at least 18 m (60 ft) from the center line of the weigh span of the scale.

(c) There shall be no concave curve in the conveyor between the scale and the loading point. A concave curve beyond the scale shall start no closer than 12 m (40 ft) from the scale.

(d) There shall be no tripper or movable head pulleys in the conveyor.

*(e) The conveyor shall be no longer than 300 m (1 000 ft) or shorter than 12 m (40 ft) from head to tail pulley.*
*[Nonretroactive as of January 1, 1986.]*

(f) Conveyor stringers at the scale and for not less than 6 m (20 ft) before and beyond the scale shall be continuous or securely joined and of sufficient size and so supported as to eliminate relative deflection between the scale and adjacent idlers when under load. The conveyor stringers should be so designed that the deflection between any two adjacent idlers within the weigh area does not exceed 0.6 mm (0.025 in) under load.

(g) The scale area and 4 idlers on both ends of the scale shall be of a contrasting color, or other suitable means shall be used to distinguish the scale from the remainder of the conveyor installation, and the scale shall be readily accessible.

(h) Conveyor belting shall be no heavier than is required for normal use. Under any load, the belt shall contact the center or horizontal portion of the idlers. Splices shall not cause any undue disturbance in scale operation (see N.3.).

(i) The conveyor loading mechanism shall be designed to provide uniform belt loading. The distance from the loading point to the scale shall allow for adequate settling time of the material on the belt before it is weighed. Feeding mechanisms shall have a positive closing or stopping action so that material leakage does not occur. Feeders shall provide an even flow over the scale through the full range of scale operation. Sufficient impact idlers shall be provided in the conveyor under each loading point to prevent deflection of the belt during the time material is being loaded.

(j) The belt shall not extend beyond the edge of the idler roller in the weighing area.

***UR.2.3. Material Test.*** *- A belt-conveyor scale shall be installed so that a material test can be conveniently conducted.*
*[Nonretroactive as of January 1, 1981.]*

2.21. Belt-Conveyor Scale Systems

**UR.2.4. Belt Travel (Speed or Velocity).** - The belt travel sensor shall be so positioned that it accurately represents the travel of the belt over the scale for all flow rates between the maximum and minimum values. The belt travel sensor shall be so designed and installed that there is no slip.

**UR.3. Use Requirements.**

**UR.3.1. Loading.** - The feed of material to the scale shall be controlled to assure that, during normal operation, the material flow is in accordance with manufacturer's recommendation for rated capacity.

**UR.3.2. Maintenance.** - Belt-conveyor scales and idlers shall be maintained and serviced in accordance with manufacturer's instructions and the following:

(a) The scale and area surrounding the scale shall be kept clean of debris or other foreign material that can detrimentally affect the performance of the system.

(b) Simulated load tests shall be conducted at periodic intervals between official tests, to provide reasonable assurance that the device is performing correctly. The action to be taken as a result of simulated load test is as follows:

- if the error is less than 0.25 percent, no adjustment is to be made;

- if the error is at least 0.25 percent but not more than 0.6 percent, adjustment may be made if the official with statutory authority is notified; (Amended 1991)

- if the error is greater than 0.6 percent but does not exceed 0.75 percent, adjustments shall be made only by a competent service person and the official with statutory authority shall be notified. After such an adjustment, if the results of a subsequent test require adjustment in the same direction, an official test shall be conducted; (Amended 1991)

- if the error is greater than 0.75 percent, an official test is required. (Amended 1987)

(c) Scale Alignment. - "Wire line" (0.5 mm or 0.02 in diameter piano wire or equivalent nylon line) alignment checks shall be conducted when conveyor work is performed in the scale area or in accordance with manufacturer's recommendation. A materials test is required after any realignment.
(Amended 1986)

(d) Simulated Load Equipment. - Simulated load equipment shall be clean and properly maintained.

(e) Records. - Records of calibration and maintenance, including conveyor alignment, shall be maintained on site for at least three current years to develop a history of scale performance. Copies of any report as a result of a test or repair shall be mailed to the official with statutory authority as required. The current date and correction factor(s) for simulated load equipment shall be recorded and maintained in the scale cabinet.
(Amended 1991)

**UR.4. Compliance.** - Prior to initial verification, the scale manufacturer or installer shall certify to the owner that the scale meets code requirements. Prior to initial verification and each subsequent verification, the scale owner or his agent shall notify the official with statutory authority in writing that the belt-conveyor scale system is in compliance with this specification and ready for material testing.
(Amended 1991)

AUTOMATIC WEIGHING

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WEIGHING TOWARDS THE YEAR 2000
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# Authorized weigh-in-motion installations in Romania

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*Abstract*

*This paper presents the studies and realizations of the authors in the field of weigh-in-motion (WIM) of railroad wagons and trucks. The authors are authorized by the Romanian Bureau of Legal Metrology as producers for electronic WIM equipment.*
*The railroad weighbridge was tested and approved in accordance with the OIML R 106 specifications. For truck weighbridges, the testing was also carried out following R 106 specifications, whenever possible.*
*The obtained performances are class 0.2 for the total of wagons at a speed up to 10 km/h, and class 2 for trucks at a speed up to 4 km/h.*
*The installation's structure and operation are detailed hereafter. Special attention is paid to the plane distortions in the approaching zones, and a suggestion is made to reinsert these specifications into R 106. The authors also believe that an OIML recommendation on WIM installations for trucks should be mandatory.*

## Introduction

Building a weighing installation for vehicles in motion (dynamic weighing) involves solving many metrological, mechanical, electronic, informatique, civil building and, in the case of railroad weighing, railroad building problems.

The complexity of dynamic weighing, compared with static weighing, is due to the existence of additional error sources:

- vibrations due to vehicle motion (absent during static weighing);
- weighing time (unlimited or sufficient time for static weighings; for dynamic weighing, the time depends on the vehicle speed and the load bridge length);
- partial weighing (the total weight for a vehicle is obtained by adding partial weighings; due to the size of different types of vehicles which must be weighed dynamically, a platform supporting the entire vehicle cannot be used);
- the coupling system of the wagon (weight transmission by couples, from one vehicle to another).

In order to minimize the effects of additional error sources during the dynamic weighing, special constructive solutions and specific weighing algorithms must be used. With an additional cost, weighing in motion offers important advantages in certain applications because there is no need to stop the vehicle on the weighbridge (usually a difficult and time-consuming operation), and because the operator intervention is reduced to a minimum.

## Brief history

The first test for building WIM machines in Romania began in 1974, when a axle of a wagon was weighed using self-manufactured load cells. At the beginning of the 1980's, four rail weighing installations, equipped with Hottinger load cells, were approved in class 1 (speed up to 4 km/h). At the end of 1980's, the second generation arrived, bringing improved performances (class 0.5) in the equipment. The performances of the third generation, which began in 1992, based on a PC-AT computer and Hottinger load cells, are presented below.

## Metrological features

The WIM installation for trains (ICMV-01) has the following metrological features:

- Accuracy in static weighing: class III (as defined by OIML R 76), with a scale interval of 20 kg and and the number of scale intervals being 2 500

- Accuracy for weighing-in-motion (as defined by OIML R 106): class 0.2 for train weighing, class 1 for wagon weighing
- Maximum operating speed: 10 km/h
- Minimum operating speed: 0 km/h
- Weighing method: two partial weighings per wagon
- Maximum number of wagons per train: 50
- Maximum wagon weight: 100 t
- Scale interval: 100 kg
- Bi-directional weighing
- Automatic locomotive detection

The installation was authorized by the Romanian Office for Legal Metrology with pattern approval number 205/1994, attesting its compliance with OIML R 106 requirements. It is operating in 8 sites: seven installations are found in the most important Romanian coal power stations and the eigth is the Bucharest-Constanta highway building site (for weighing building materials).

For the dynamic weighing of trucks, the ICMA-03 installation was achieved (required by the National Administration of Roads). It determines axle weights (the weights being used at transit charge calculation). This installation has the following metrological parameters:

- Accuracy in static weighing: class III (as defined by OIML R 76), with a scale interval of 20 kg and the number of scale intervals being 750
- Accuracy for weigh-in-motion: 1 % for the total weight of the truck, 100 kg for an axle
- Maximum operating speed: 4 km/h
- Minimum operating speed: 0 km/h
- Weighing method: partial weighing
- Maximum number of axles per truck: 10
- Maximum axle weight: 15 t
- Scale interval: 100 kg

The installation was authorized by the Romanian Office for Legal Metrology with pattern approval number 027/1993, and is used in 10 border crossing points.

## Description

The general scheme of the dynamic weighing installations is shown in Fig. 1 (not at scale). The main components of the installation are:

1. Load receptor (weighbridge, weighing platform):
   a. For rail vehicles, the bridge length is 4.2 m (dimension imposed by the minimum distance between two linked axles of a wagon); the bridge has proximity inductive sensors for transit sense detection, speed determination, locomotive detection;
   b. For road vehicles, the bridge length is 0.7 m (this allows axle isolation);

2. Weight sensors: convert the weight of the load receptor in electrical values (four load cells):
   a. C3H3-20 t Hottinger type cells (with 3 000 OIML scale intervals) for rail weighing installations;
   b. C3H3-5 t Hottinger type cells (with 3 000 OIML scale intervals) for road weighing installations;

3. Electronic weighing equipment (AWE-03 with pattern approval number 207/1994 issued by BRML) including:
   a. A signal amplifier and analogue to digital converter (located in the computation unit). The signal generated by the load cells is converted in 16-bit digital values with an acquisition rate of 33 samples/s ;
   b. Computation and display unit (PC-AT structure). The use of a PC for processing offers some advantages:
   - The possibility to implement complex algorithms to eliminate the vibrations effects;
   - The possibility to store a great number of records;
   - The possibility to store the primary information obtained in the weighing process (useful for locating assembly problems and for studying the installation behavior in time);
   - The possibility to accomplish customer specific processing;
   - The possibility of standard remote transmission of weighing results;

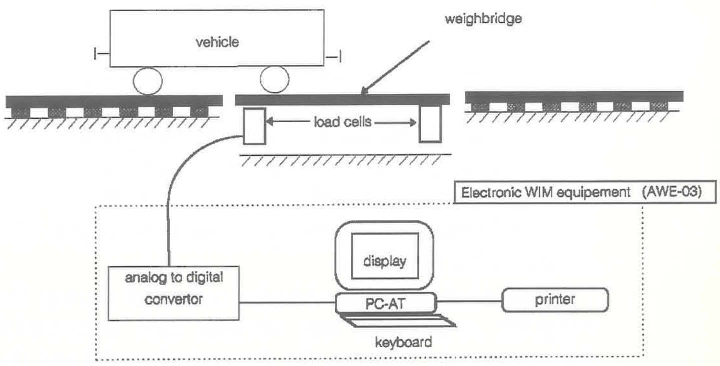



Fig. 1 Components of weigh-in-motion installations.

- Basic operation and maintenance (generally already known by the user).

In order to ensure data and program security, validation and identification procedures were implemented: metrological operations can only be carried out from external supports; a unique code (specified on all the printed documents) is assigned to each metrological operation; passwords and/or security devices and control codes are used to detect the intended or accidental altering of data or programs.

## Vibration attenuation

The theoretical signal generated by the load cells while the weighing bridge is crossed by the vehicle is presented in Fig. 2. Initial and final transient periods (generated by the bridge-vehicle impact), surround a weighing period in which the indication includes the true value with fluctuating components. In the weighing period, the fluctuating component must be processed to obtain the weight value with a determinate accuracy. Because sample values are received at equal time intervals, the weight calculation is a numerical analysis problem, particularly a numerical integration problem.

For wagon weighing, the vibration effect analysis was done using samples collected during the weighing of more than 3 000 wagons at different transit speeds. Transit speed percentage distribution is presented in Fig. 3. The percentage distribution of the oscillation frequencies and amplitudes are shown in Figs 4 and 5. For frequencies ranging between 2.5 and 8.5 Hz, oscillations up to ± 8 % of the true value must be attenuated. The minimum weighing time, 2/3 of a second, is imposed by the bridge length, the distance between two linked axles, and the maximum weighing speed.

To obtain a minimum processing time, allowing complete processing of a sample till the acquisition of the next one, the following processing solution was chosen: weight averages of 32-bit integers (floating point calculus is avoided).

By choosing an adequate weight function during a 2/3 of a second measurement period for frequencies between 2.5 and 8.5 Hz, oscillation attenuation greater than 100 can be obtained. For such a weight function, the resulting attenuation for the theoretical model oscillations is presented graphically in Fig. 6 (the attenuation obtained by using simple averaging is also plotted with a thin line).

From analyzing the samples collected during the weighing process, it was obvious that substantial differences exist between the theoretical model and the sample. A typical waveform is presented in Fig. 7.

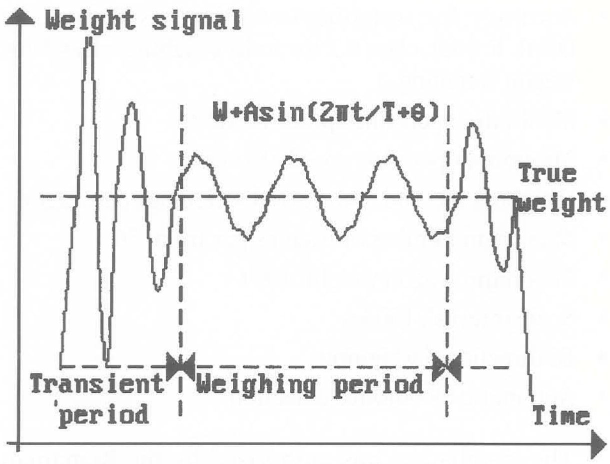



Fig. 2 Theoretic signal generated by the load cells.

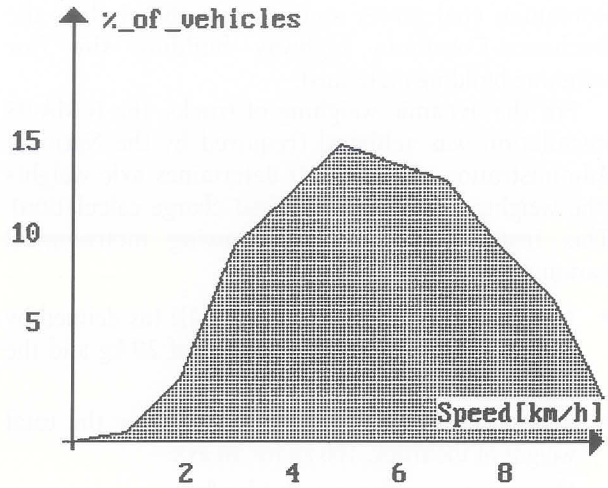



Fig. 3 Transit speed distribution of analyzed wagons.

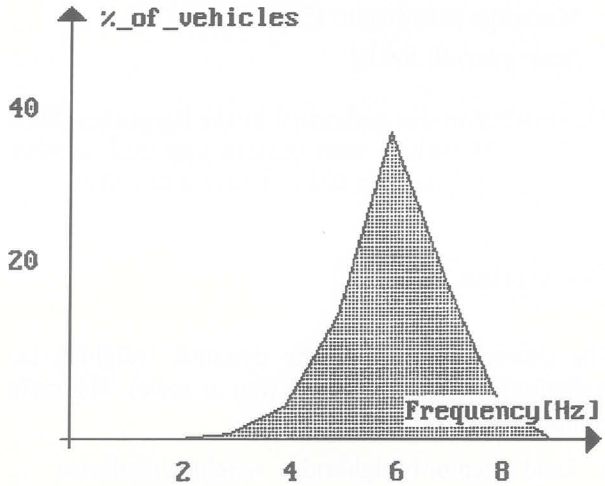



Fig. 4 Percentage distribution of oscillation frequencies for analyzed wagons.

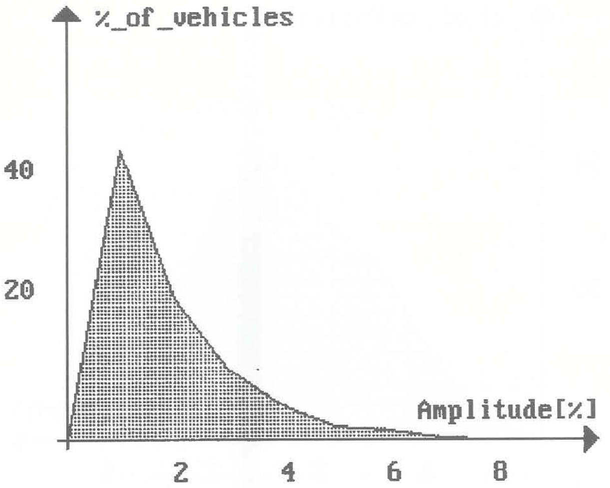



Fig. 5 Percentage distribution of oscillation amplitudes for analyzed wagons.

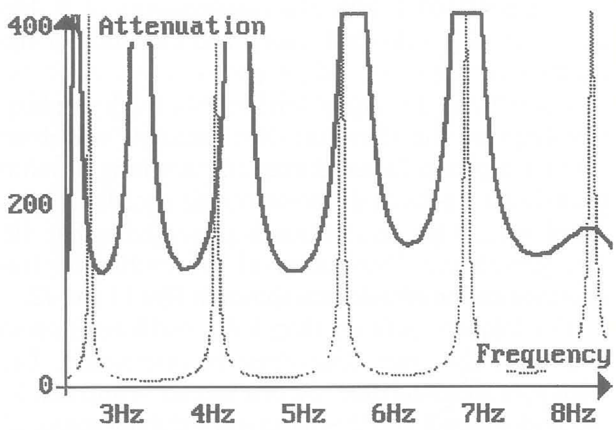



Fig. 6 Theoretical model oscillations attenuation for special averaging versus simple averaging (for 2/3 of a second weighing period).

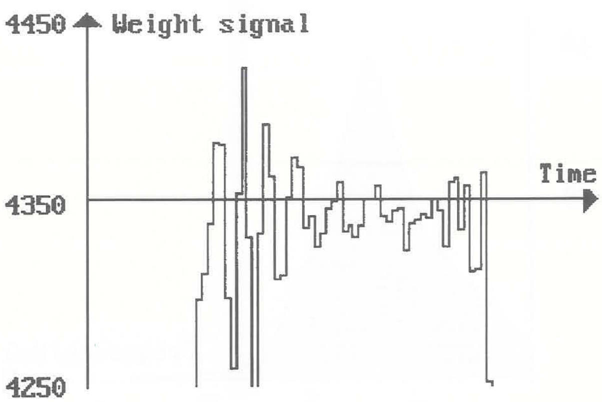



Fig. 7 Typical wave form.

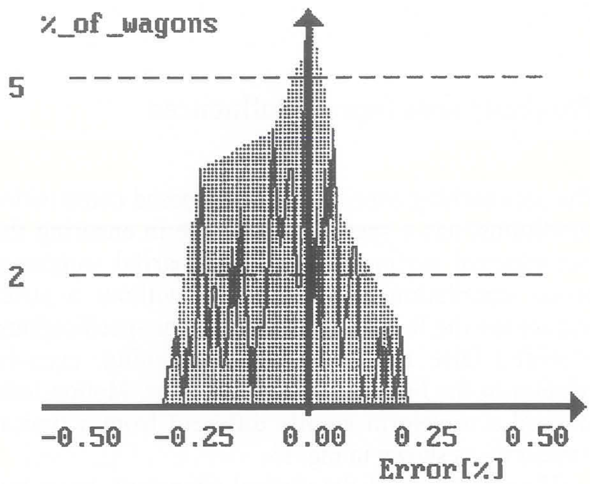



Fig. 8 Error distribution.

The differences from the theoretical model impose the use of adaptive calculus algorithms (different weighing functions for different transit speeds and vehicle oscillation amplitudes), which permit one to detect cases in which measurement results are not in the range of the tolerated error (weight changes generated by brakes or accelerations). The general distribution of the errors obtained using dynamic algorithms, is presented in Fig. 8. The general error distribution is:

- less than 0.1 % — 61 % of wagons
- between 0.1 % and 0.2 % — 33 % of wagons
- greater than 0.2 % — 6 % of wagons

The coupling effects for a test train is presented in Fig. 9. Because of the coupling effects, the percentage accuracy obtained for individual wagons is lower than the percentage accuracy for the entire train.

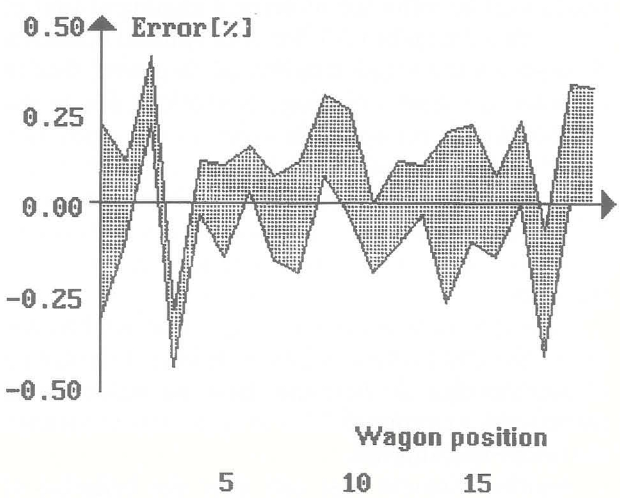



Fig. 9 Error distribution depending on the wagon position in the train.

These tests lead one to conclude that the weighing system ICMV-01 fulfills the requirements of R 106 class 1 for the individual wagon and class 0.2 for the train.

Analogue to the wagon weighing, for truck weighing installations, the vibration effect analysis was done using samples collected during the weighing of more than 1 000 trucks at different transit speeds. Transit speed percentage distribution is presented in Fig. 10. The percentage distribution of the oscillation frequencies and amplitudes are shown in Figs 11 and 12.

For frequencies lower than 8 Hz, oscillations up to ± 6 % of the true value must be attenuated. The minimum weighing time, 1/2 of a second, is imposed by the bridge length and the maximum weighing speed. To attenuate the oscillations, special algorithms (different from algorithms used for weighing wagons) are used in order to maintain the errors within the maximum permissible errors.

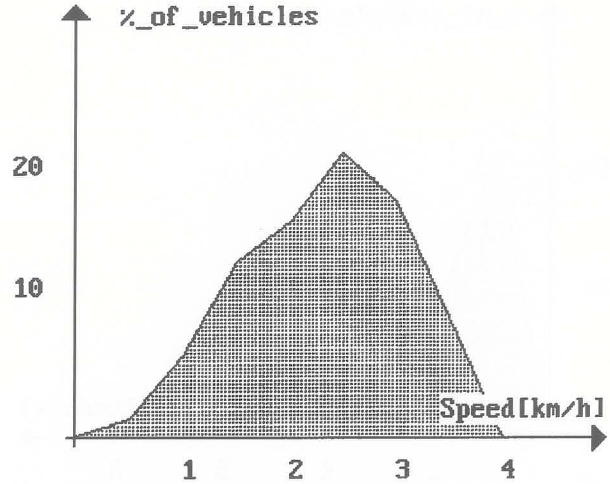



Fig. 10 Transit speed distribution of analyzed trucks.

## Proximity area (apron) influences

The approaching zone, due to its imposed constructive conditions, has a special importance in ensuring the metrological performances in the partial weighing. Some installations, built initially without a strict respect for the R 106 vertical alignment specifications, provided false results in static weighing, even in relation to the bridge approaching sense. Motion tests showed a waveform greatly different from a typical waveform, as shown in Fig. 13.

The correction of the vertical alignment, to its imposed limits, greatly improved the accuracy in static and weigh-in-motion, thus confirming the correctness and necessity of these conditions in R 106 specifications. The influence of vertical alignment (out of level over ± 2 mm) in a 2.5–3 m zone situated upstream/downstream the trucks weighbridge, is greater than in the case of wagon weighing installations due to the springs which act upon the axles of the truck (the repartition of the axle loads is done according to the characteristics of these springs). Variations in level near the weighing platform will produce a load transfer, from one axis to another, altering the weighing accuracy.

Figure 14 presents a typical load transfer between close axles due to these variations of level in the aprons of weighbridge. A worn-out layer to be corrected periodically, in a zone of 2.5–3 m upstream/downstream the bridge was imposed.

Another element that can alter the behavior of installations over a period of time, is the change in access zone in the case of installations that do not have

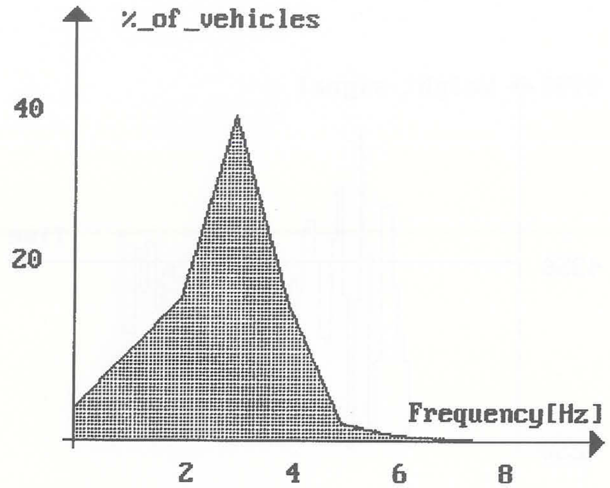



Fig. 11 Percentage distribution of oscillation frequencies for analyzed trucks.

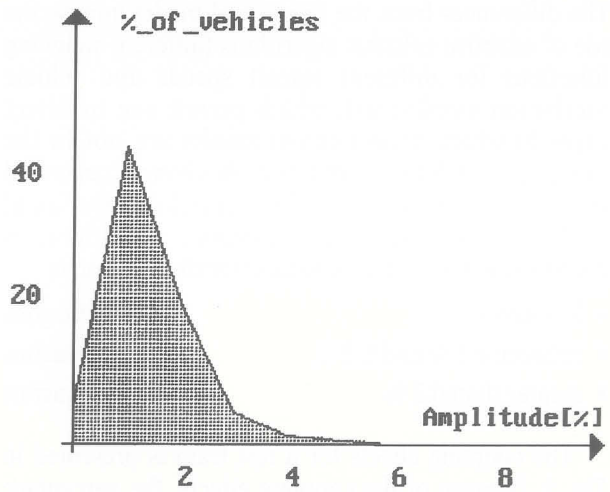



Fig. 12 Percentage distribution of oscillation amplitudes for analyzed trucks.

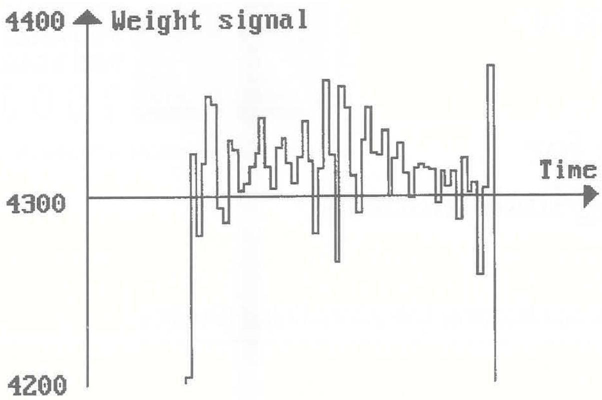



Fig. 13 Vertical alignment influences on the waveform.

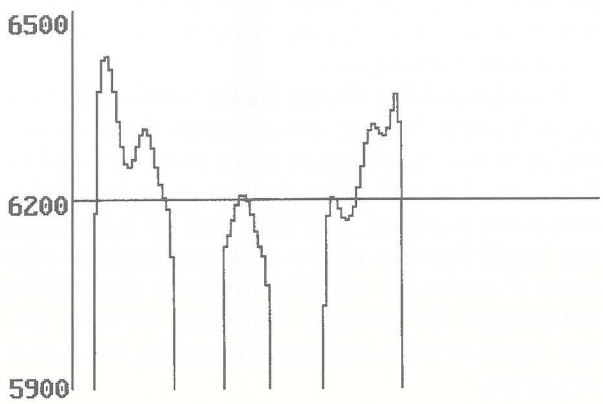



Fig. 14 Transfer load due to variations in level.

a reinforced concrete foundation and an appropriately reinforced approaching zone. In this case, due to the combined effects of infiltrated water, freezing, and crumbling of gravel, inherent changes in the apron levels are produced. These installations, in order to be authorized, would have to be equipped with inclination sensors (acting when imposed limits are exceeded).

## Conclusions

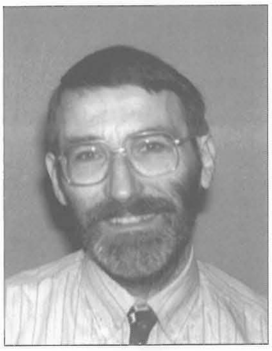
The specific conditions of certain countries (Romania, for example) impose, in addition to the custom control, the check-up of axle loads of trucks in order to respect the norms for road protection, that is why the dynamic weighing installations have to be authorized by the Legal Metrology Offices of these countries. Different interpretations of the same vehicle weight on the dynamic weighing installations from one side and the other side of a border could be avoided by elaborating appropriate international regulations.

Therefore, a recommendation project in the field of dynamic weighing installations for road vehicles, perhaps based on R 106, should be useful for providers, users and metrological services as well. Certain aspects such as: apron zone length, vertical alignment imposed to aprons, etc. should be specified. References to the conditions of mobile and semi-mobile installation acceptance should also be included. ■

**CORRIGENDA**

OIML Bulletin Vol. XXXVII, Number 1, January 1996
p. 8, section 5.2

All time indications shall be given in µs (instead of ms) except in the 2nd column, 3rd paragraph, line 11 ("The corresponding time interval of 1 ms is influenced by the 1 µs interrupt jitter with a relative uncertainty of $10^{-3}$, ten times less than the 1 % periodic variation....") which is correct.



OIML Seminar
WEIGHING TOWARDS THE YEAR 2000
13–15 September 1995 Maison de la Mécanique, Paris

DEVELOPING CONSISTENT RECOMMENDATIONS

# Recommendations for automatic weighing instruments

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## Scope and history

This paper will review the process of developing Recommendations for automatic weighing instruments and explain some of the innovations that have been agreed. The subcommittee responsible for the Recommendations is OIML TC 9/SC 2 and the Secretariat is held by the UK (NWML).

The origins of the task date back to 1963 when it was first agreed that international Recommendations were required for discontinuous totalizers. Since that time three Recommendations - R 50 for beltweighers, R 51 for catchweighers and R 61 for gravimetric filling instruments, have been published and then overtaken by technical developments. These have now been redrafted along with two new Recommendations - R 106 for automatic rail-weighbridges and R 107 for discontinuous totalizers. All five are now agreed drafts.

## Principles of classification

To understand the process of developing the Recommendations it is first necessary to examine how the different instrument types have been classified. The starting point for specifying the metrological features, limits of error and test procedures is the definition of the instrument. We have to accept that the definition is generally not based on the application but on the function of the instrument and sometimes, by implication, on the technology which is employed.

Generally, an automatic weighing instrument does not simply weigh a commodity; it weighs in a certain circumstance and sometimes, by virtue of certain functions: a rail-weighbridge, for example, has a very different function to a bag filler even though they may both be weighing coal. Therefore it is useful to distinguish the application from the functionality. The application is a rather general term which includes the circumstances and the product to be weighed. We use the term functionality to refer to the capability of the instrument - the general property of what it can do. (This may be a more familiar term to software engineers than to metrologists.)

It is also useful to distinguish the functionality from the technology. In some circumstances the technology employed is a critical feature of the instrument and the Recommendation. Perhaps the best example is R 50 - continuous totalizers. R 50 is written for beltweighers and would therefore not be easily applicable to other forms of continuous totalizers. There are also enabling technologies (for example, electronics, software, etc.) that may have to be considered in applying the Recommendations.

In general terms, there is a kind of spectrum:

Application – functionality – technology – enabling technology

It is generally agreed that to be most useful and least restrictive, the Recommendations should ideally be based on applications; they should take account of functionality and only where necessary should technology be specified. This has been accepted as one of the general objectives in drafting the Recommendations but it is subject to the practical requirements of specifying and controlling actual weighing instruments.

Thus, we have five Recommendations which vary a great deal in scope and which may not be based on the ideal method of classification, but which practically cover all automatic weighing instrument requirements.

## Methods of specifying accuracy

The various methods of specifying the limits of error (referred to as "error regimes") will be reviewed hereafter and their relation to the application and functionality of the instruments will be shown. This is the key to the whole Recommendation in each case (Fig. 1).

| ERROR LIMITS | Type: | Absolute | Relative | Absolute | Relative* | Relative* | Relative* |
|---|---|---|---|---|---|---|---|
| | Applied to: | TOTAL ERROR (STATIC) | TOTAL ERROR | MEAN ERROR | MEAN ERROR | DEVIATION FROM MEAN | STANDARD DEVIATION |
| | Specified by: | SCALE INTERVALS | % OF LOAD | SCALE INTERVALS | % OF LOAD (Or mass)* | % OF LOAD (Or mass)* | % OF LOAD (Or mass)* |
| R 76 | | ✔ | | | | | |
| R 51 | | | | ✔ | | | ✔ |
| R 61 | | | | | ✔ | ✔ | |
| R 50 | | | ✔ | | | | |
| R 107 | | | ✔ | | | | |
| R 106 | | ✔ | ✔ | | | | |

Fig. 1 Methods of specifying limits of error.

(*) Relative error with increased allowance at small masses. It is necessary to specify the error limit by mass for the ranges of measurement between which the various relative error limits are applied.

A different method has been used in almost every Recommendation. In retrospect, it may be possible to make some simplifications but in principle, each error regime is appropriate to the application and functionality of the instrument. In the case of a non-automatic instrument, where the principal purpose of the instrument is to indicate weight, it is natural to specify accuracy in terms of the indication. So, for R 76 the limits of error are specified by scale intervals.

For automatic instruments there is usually some compromise related to the practicality of testing (i.e. to the technology) but the error regime is based on the application, where possible.

For industrial applications, it is generally appropriate to specify maximum permissible errors relative to the mass of the load - i.e. relative error limits. For totalising instruments (R 50 and R 107), the effect of random errors is small, being averaged over a greater quantity, so the accuracy is specified simply by a total relative error. For gravimetric filling instruments (R 61), the accuracy of the fill is more important than the indication. Therefore, R 61 specifies relative error limits, for mean and maximum deviation, for the fill.

R 51 (class X) was originally developed for checkweighers used in the implementation of average weight packing. In this application the scale interval, the mean error and the distribution of errors are all relevant. Therefore, the mean error is specified in terms of scale intervals, and random errors are specified by the maximum permissible standard deviation (mpsd). The mpsd is related to the requirements of R 87 (Net content in packages) in which there is a series of relative error limits appropriate to the package size.

R 107 specifies a total relative error limit and an allowable range for the verification scale interval that is related to the error limit. In principle, this appears to be the most logical way to specify the requirements for any measuring instrument.

One consequence of specifying a relative error is that, for a given instrument design, most sources of error are more significant for smaller measured quantities; it is therefore necessary to specify a minimum capacity for each type. This is defined as a "rated" minimum to be specified by the manufacturer, who thus has the responsibility and freedom to optimize the design.

## Accuracy classes

Having accepted that the scope of each Recommendation is defined largely by instrument functionality, it is then necessary to deal with the wide variety of applications that may be encountered for any instrument type. For each Recommendation there is possibly a wide range of accuracy requirements. Perhaps not all applications are subject to regulation, but each Recommendation should enable the regulation, if necessary, of all instruments that fall within its scope. The objective is not to restrict but to enable control where necessary. Therefore a range of accuracy requirements must be defined.

The established practice is to divide each category of instrument into a number of accuracy classes so that limits of error may be defined for each class relative to the function of the instrument. Nonautomatic weighing instruments have four classes which are effectively 10:1 apart, giving an overall range of accuracy of 1000:1, in addition to the flexibility offered by the selection of the scale interval. This is necessary because of the very wide range of products that may be weighed. A similar scope of application is required for some automatic weighing instruments:

R 107 has four accuracy classes - 0.2, 0.5, 1.0 and 2.0, these being the percentage values of the maximum permissible errors (in-service). By a similar method, R 50 has three classes and R 106 has four. The overall range of accuracy that may be specified is, however, fairly small in each case.

For R 51 and R 61, TC 9/SC 2 has developed a system of open classes. In this system, an instrument may be verified and marked as being class X(x), where (x) is known as the class designation factor and is a multiplier of the limits specified for class X(1). X represents the error regime, the limits for which are to be multiplied by the designation factor (x). For example, in the case of gravimetric filling instruments, the regime consists of a number of different maximum permissible deviations from mean (depending on the range of load weights) and a maximum permissible mean error which is 0.25 of maximum permissible deviation. Class X(1) has 1 % mpd for loads greater than 15 kg. For other classes, this limit is multiplied by (x) along with all the other specified limits. If it is necessary to define an alternative error regime within a given category of instrument; an alternative class designation letter can then be used, e.g. class Y(y).

The principle can be illustrated as follows: Fig. 2 shows a number of possible error regimes, any one of which could be termed X. Figure 3 shows the effect of applying various values of the Multiplier (x) to one particular error regime. For practical purposes of definition and control, it is necessary to specify that the designation factor (x) shall be $1 \times 10^k$, $2 \times 10^k$ or $5 \times 10^k$, the index k being a positive or negative whole number or zero.

Application of classes is generally defined in national legislation as appropriate to the area of use and materials being weighed. The principle is long established but may easily be forgotten in planning for use of OIML Recommendations, and standards based on them, in emerging legislation.

The concept of open classes provides a method of specifying accuracy which is precise but extremely flexible, giving regulatory authorities the means for control while placing no unnecessary constraints on commerce and development.

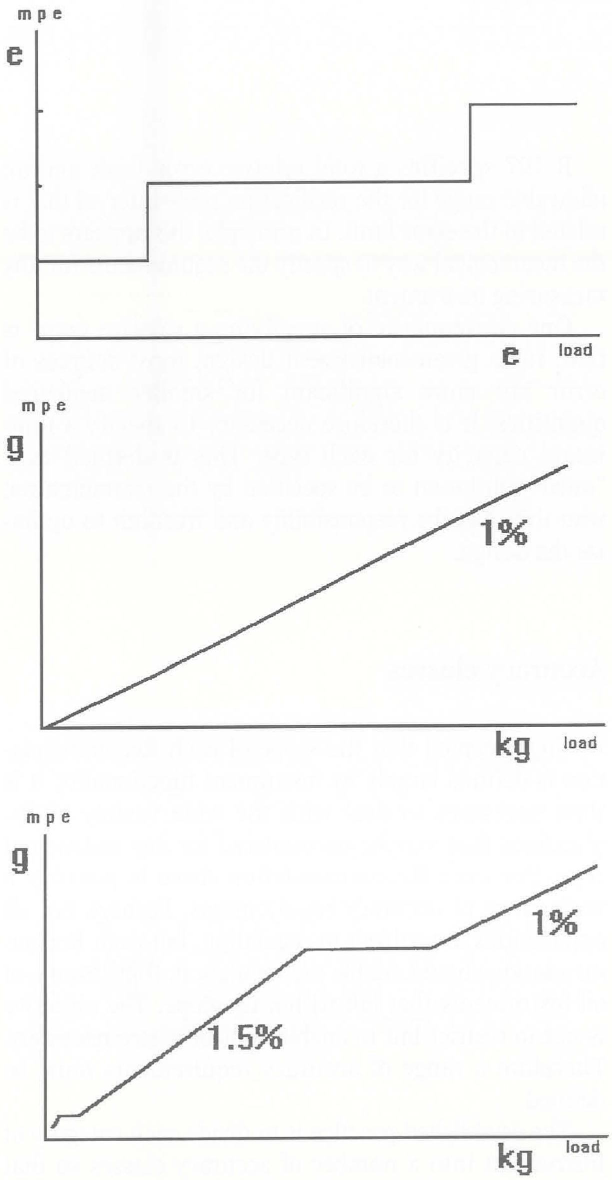



Fig. 2 Error regimes.

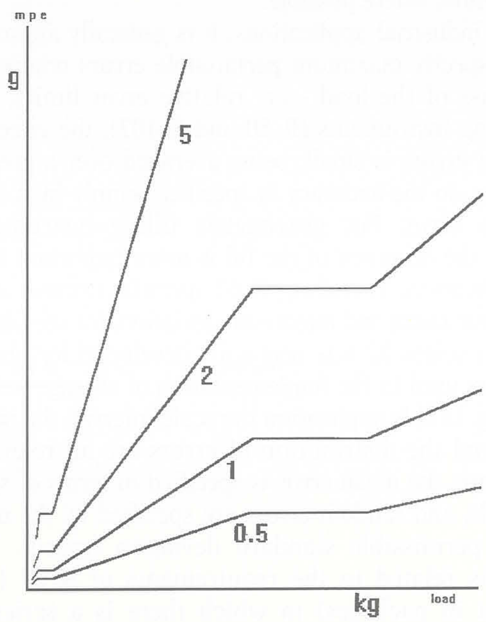



Fig. 3 Accuracy classes.

## R 61 reference accuracy class

Applying the principle of open classes to R 61 has led to another development: the error limits for R 61 are defined in terms of the accuracy of the fill, this being the most important requirement for a filling instrument. The accuracy of the fill is dependent on the ability of the instrument to handle the type of material that constitutes the fill; it is therefore logical that the instrument should be tested with the material that is intended to be weighed.

However, it is generally not possible to do material tests while influence quantities are being applied. Even if material tests could be done at this stage, it would be unreasonable to restrict future use only to the material used for the test. Unless we are to approve instruments only for a generic material type, it is necessary to complete the material tests at the time of initial verification, and to specify the material that may be processed in normal use at that stage. An accuracy class may then be determined for any given material type.

What can be tested at the approval stage is the accuracy of the weighing function in a static mode when subjected to all the specified influence quantities, and also the basic operation of the material control equipment. It is possible to allocate a reference accuracy class based only on the results of influence quantity tests under static conditions. This is a measure of the accuracy of the basic weighing function and represents the best possible performance that may be obtained.

A filling instrument approved and verified under R 61 will therefore have a reference accuracy class and one or more operational accuracy classes depending on the materials that are to be weighed. In all cases, the class is determined by the worst of a number of test results. Detailed test procedures have been written to enable a uniform application of the principle. The procedure can be illustrated by flow diagrams: Fig. 4 for the reference accuracy class, and Fig. 5 for the operational accuracy class.

It appears that the only disadvantage of this approach is that the approval certificate relates to the static weighing capability and not to the accuracy of the filling function. Therefore, as part of the technical examination for approval, it is specified that the instrument must be operated with a typical material to ensure that the design can function adequately in its basic mode of operation, i.e., as a filling instrument.

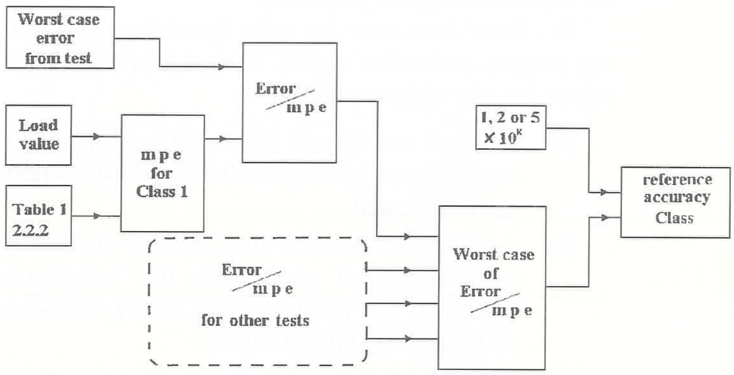



Fig. 4 Procedure to determine reference accuracy class.

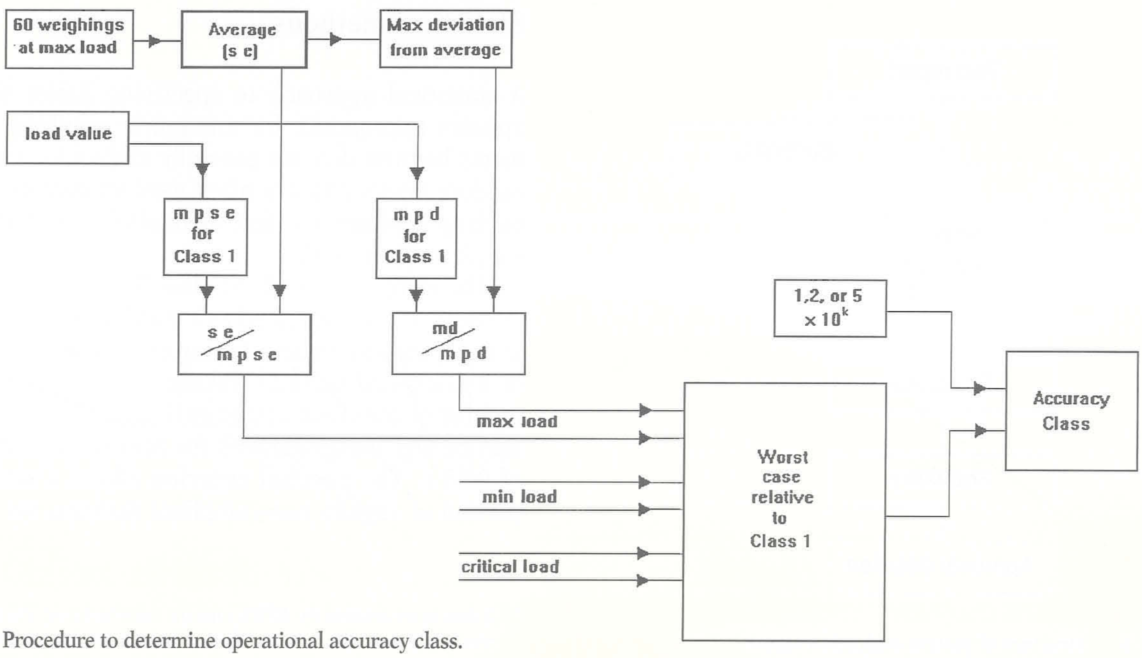



Fig. 5 Procedure to determine operational accuracy class.

## Documentation structure and supplementary documents

The main documents for each Recommendation were drafted with an annex containing the influence quantity tests. Annex A is supplementary to the test methods for basic metrology, which are in chapter 6. This structure appears to have evolved as the test requirements of electronic instruments were added to the recommendations.

More recently, a detailed test procedure document was developed for each Recommendation. The objective was to bring together all the tests in one rationalised document, and to provide additional test information where necessary - typically for secondary parameters which are difficult to test, such as zero setting accuracy. The test procedure document may be considered as a part of the Recommendation, being an integral part of the legal metrological procedure.

The third document for each Recommendation is the pattern evaluation report. The pattern evaluation report has two main sections:

(a) Detailed test report forms with a format to record the processing of measured values into test results, and

(b) A full check list where all of the test results can be summarised along with the functional checks. At this point, the pass or fail decisions may be made and recorded.

The format of the pattern evaluation report forms is designed to facilitate the separation of the test procedure from the design examination and approval decision process (Fig. 6).

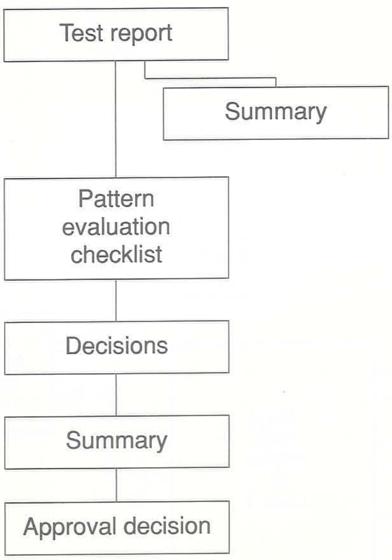



**Fig. 6** **Structure of pattern evaluation report.**

The package of documents has been agreed as functionally correct, but it can be improved structurally (the influence quantity tests of Annex A are repeated in the test procedure document in order to make this a stand-alone document*). However, we now have a sufficiently defined and complete test package to achieve a reasonable consistency of test procedures between the different test laboratories - an essential requirement for establishing consistency of metrological standards. This is of prime importance in achieving a single market for weighing instruments and also for international trade in many bulk and packaged commodities that are weighed automatically.

It is also a means to establish a common currency of test results that are exchangeable between the laboratories so that, in principle, it is not necessary for all tests to be done by one laboratory. This will become a significant advantage in approval testing of modifications and developments of instruments. For practical engineering and economic reasons, it is normal to modify existing designs of instruments rather than to create entirely new designs. Instruments are therefore offered for approval with only minor modifications or modifications to only part of the system. In these circumstances, a complete test of the whole machine is often not necessary. The agreed test procedures and common format of test results makes it practical to carry forward test results, where appropriate, from previously approved patterns of instruments, thus reducing the cost to industry and encouraging innovation rather than inhibiting it. To summarise, the supplementary documents will enable a more transparent implementation of the Recommendations with benefits for industry and the metrological authorities.

## Statistical methods

A statistical approach to specifying limits of error appears appropriate for automatic weighing instruments because they are generally subject to significant random errors and are often used in average weight packing applications. Test methods however, must be simple and practical.

Therefore, only for R 51 class X (checkweighers) is the limit of error specified as a standard deviation. Also in R 51, the test for zero setting error allows the option of a statistical method (taking the mean value of a number of zero-load weighings) because random errors may be high compared with the zero setting error limit of 0.25 e. The pass/fail criterion allows a small proportion of slightly non-compliant instruments to pass

* *It has been decided by BIML and the secretariat of TC 9/SC 2 to print the former Annex A and the test procedures in a single Annex.*

the test in order that most of the compliant instruments be accepted. For marginal failures, the tester is advised to use a larger sample or a different test.

It is assumed that the true mean $\mu$, of a population of readings at zero-load, is equal to the zero error. The uncertainty associated with $\bar{x}$, the estimator of the true mean, is related to the standard deviation **s** of the indications and to the number of weighings (**n** = 60). The "accept" criterion

$$|\bar{x}| \leq 0.25\ e - 0.167\ s$$

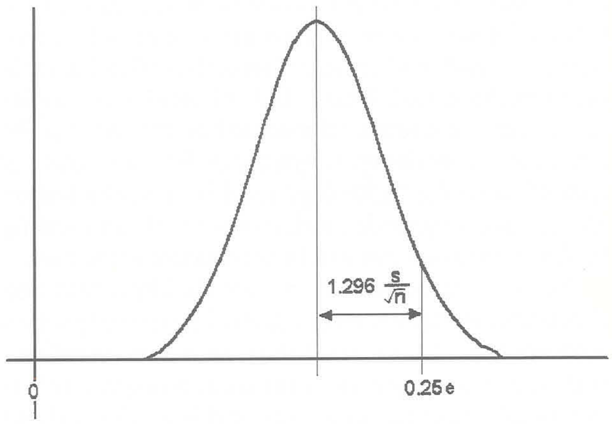
is derived from the **t** distribution, and gives a probability of 0.9 that $\mu$, the zero error, is not greater than 0.25 e (Fig. 7a). However, if $\mu$ = 0.25 e, there is a 0.9 probability of rejecting the instrument (Fig. 7b). Therefore, the draft test procedure advises that if

$$0.25\ e > |\bar{x}| > 0.25\ e - 0.167\ s$$

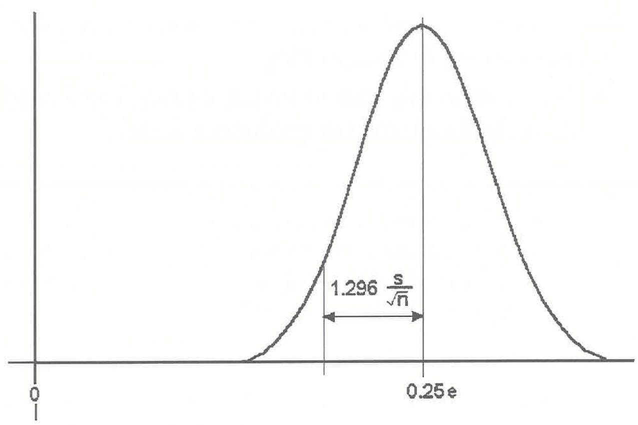
then the zero error shall be acceptable if it can be shown with 90 % confidence by other methods that the true mean $\mu$ is less than or equal to 0.25 e. If **s** is so high that the limit for $\bar{x}$ is small compared with 0.25 e, then it is obvious to the tester that the dynamic test is not practical and a static test method must be used. Other variations on the procedure are proposed. Any practical method would be acceptable for testing this minor parameter because any zero errors also appear as a systematic error in the other weighing tests. The significant point is that as soon as statistical methods are used, the level of uncertainty in the test becomes apparent.

It is important to remember that non-statistical methods involve similar compromises, as indicated, for example, by the errors we accept in the accuracy of the reference test instruments, but the compromises are then less apparent. Applying statistical methods to a study of the real significance of the test criteria already established in the Recommendations might give some interesting results, but some compromise must always be accepted if the tests are to be simple, practical and economic.

(a) $\mu = 0.25\ e - 0.167\ s$




(b) $\mu = 0.25\ e$




Figs 7(a) and 7(b) **Distribution of mean.**

## Security of dynamic setting (R 51)

Catchweighers, and checkweighers in particular, are usually used at high rates of operation where the dynamic effects are significant. In comparison with normal calibration weights, typical food packages have a low density and very different weight distribution, so that at high speeds an instrument may give consistently inaccurate results relative to static weighing.

Dynamic setting is a facility for catchweighers which allows a temporary re-calibration to compensate for the dynamic characteristics of the load. A package is weighed several times at the normal operating speed, and then the actual (static) weight of the package is entered manually as a calibration reference. Subsequent loads may then be weighed very accurately provided that they have similar characteristics and similar mass. These are also typical characteristics of many packaged goods; therefore in many cases, it is possible to eliminate nearly all systematic errors. However, the facility must obviously be readily available to the user if it is to be effective in practice. The problem for TC 9/SC 2 was that some Member States require that all calibration facilities be sealed, while others could not accept the cost implications of providing sealing facilities on every instrument.

It was eventually agreed that instruments with a dynamic setting shall also have either a static calibration facility which is capable of being sealed, or a facility for any access to dynamic setting to be automatically and non-erasably recorded. The latter is functionally a seal. This could, of course, be implemented by a conventional mechanical method, but the key factor in obtaining acceptance of the requirement is that some of the technology used in dynamic setting can be used to provide an electronic (software) sealing facility at minimal cost and inconvenience to the user.

Evidence of access can be provided by a recorded checksum, an incrementing counter or even simply by a software flag which is set if the facility is accessed and is displayed if requested via the control keypad. This is functionally identical to a traditional lead/wire seal and has the following advantages which make it an acceptable requirement:

- Unless configured for use, it is not even visible to the operator.
- It is only a small addition to the software development cost of dynamic setting.
- It is a once-only cost to manufacturers; there need be no hardware costs or production costs.

Of course, the use of the sealing facilities will be determined by national prescription. It appears quite possible that dynamic setting will prove to be so useful that eventually no Member State will prescribe that it be sealed. The electronic sealing facility may then come to be regarded historically as no more than a means to obtain agreement in TC 9/SC 2. Perhaps even on that basis it could be economically justified.

## Conclusions

OIML TC 9/SC 2 consists of 21 participating Member States, 5 Observer States and 6 organisations in liaison. Observers from industry have made some important technical contributions. To obtain agreement on a wide range of complex equipment among so many different countries, each with its own tradition of metrological control, was not always easy; in the end there had to be some compromises and some reliance on technical innovation. However, we hope that the Recommendations will now be suitable for any new instrument technologies that may arise while remaining applicable for the simplest mechanical equipment. ■

METROLOGICAL INFRASTRUCTURES

METROLOGICAL ACTIVITIES IN DEVELOPING COUNTRIES

23–24 OCTOBER 1995
BEIJING, PEOPLE'S REPUBLIC OF CHINA

# NMIs in present-day metrology

*Dedicated to Prof. Dr Kose, Vice-President of PTB, Braunschweig and Berlin, Germany, on the occasion of his 60th birthday*

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*The following paper was presented at the OIML symposium on "Metrological activities in developing countries", which was held 23–24 October 1995 in Beijing. Selected papers from the symposium will appear in this rubric in future issues of the OIML Bulletin.*

## 1 Introduction

Considerable progress will have to be made in the technical and human fields to solve future tasks. Science and technology, as well as the pertaining infrastructures in the fields of metrology, standardization and quality management, are the essential components to reach this goal. However, progress is highly dependent on the rating of research and development by politicians and the public. This essay is confined to the role of metrology in describing ways and means to achieve national metrological competence.

In this paper, accreditation of national metrological laboratories within the metrological infrastructure will be covered, and background information will be given for those colleagues who are not familiar with these problems. At present, since accreditation and certification by national metrology institutes (NMIs) have only just been initiated, we do not have sufficient experience in this field. Therefore, only present general recommendations can be presented with various options for different tasks; more consideration will be given to the tasks, status and development of NMIs, as well as how to realize and show their competence.

## 2 Aims, tasks and structure of an NMI

### 2.1 Metrological infrastructures, with PTB as an example

In most cases, metrology is the central field of activity of an NMI. As shown in Fig. 1, the NMI heads the hierarchical metrological infrastructure. There are no generally applicable rules for the structure and set-up of metrological infrastructures; they should be oriented towards the economic, technical and scientific needs of a country. However, the similarity in the tasks of NMIs has resulted in well-known basic structures:

- fundamental metrology
- industrial metrology
- legal metrology
- internationalization of metrology

Fundamental metrology comprises all the activities which deal with:

- the realization of the units of measurement ("Units of Measurement Act", the relevant implementing ordinance and the International System of Units);
- the units of measurement and their standards (realization, reproduction, conservation and dissemination);
- the measurements (methods, performance, determination of the uncertainty of measurement);
- the measuring instruments (properties, sensors, value reading etc.).

In many fields of industrial metrology, PTB makes measurement technology of the highest precision accessible to industry, thus contributing its share to preserve competitiveness. The requirements to be met by industrial metrology result from the needs and demands of the manufacturers, users and/or consumers. The ever-growing complexity of industrial products and their manufacturing methods, as well as the increasing international partition of labour in production, calls for the use of modern measuring techniques in industry and research. This requires a high standard of metrological resources and a common metrological basis.

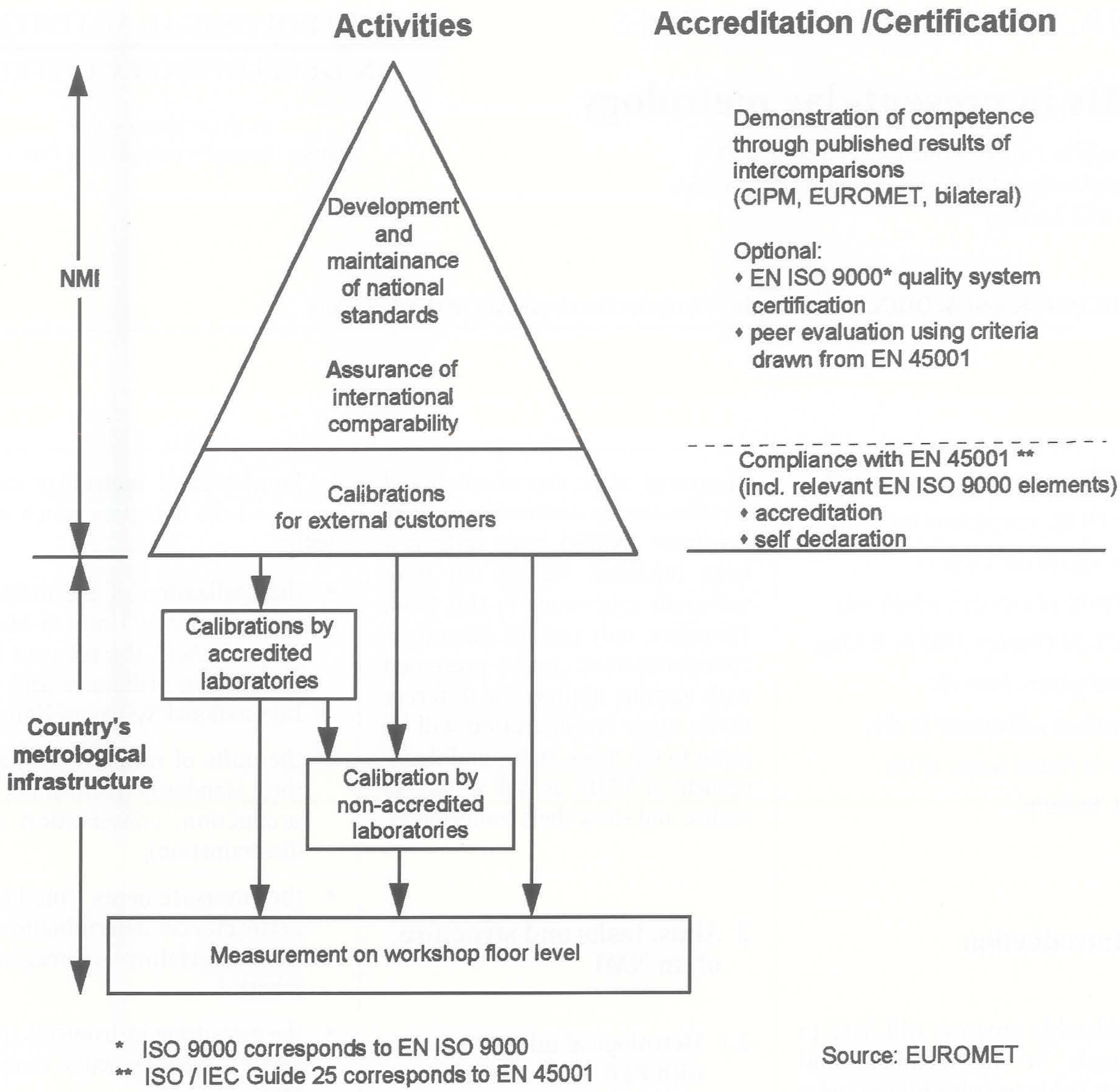



Fig. 1 An NMI heads the metrological hierarchy.

An essential factor is the demand by industry for calibrations with certified results, i.e. guaranteeing the traceability of those instruments to the official standards, even for measuring instruments which are not subject to legal control. This task is carried out by the *Deutscher Kalibrierdienst DKD* (German Calibration Service) - established and operated by the State - represented by the Ministry of Economics and PTB - and industry.

Legally controlled measuring and testing within PTB comprises verification, medical measuring techniques, radiation protection, explosion protection, civilian small arms and cartridge-operated devices, work-site protection and environmental control, as well as slot-machines and voting machines. The relevant legal references are the "Metrology and Verification Act", and further legal Acts, including the relevant implementing ordinances and additional regulations. The Metrology and Verification Act is the legal basis for the prescription of mandatory verification pattern approval, verification and other tests for measuring instruments; the accreditation of test centres for certain measuring instruments; the appointment of the executive; metrological supervision; and regulations for prepackages and capacity serving measures.

The Metrology and Verification Act lays down the tasks and responsibilities of PTB in legal metrology; PTB is the national institute of science and technology as well as the highest technical authority for metrology in Germany. The four areas of metrology in Fig. 2 show the aims, tasks and activities of a national metrology institute. As can be seen, there is a great variety of tasks from pure metrology to safety aspects. The left-hand side (Units, Time, Verification Acts) deals more with metrological tasks, the right-hand side (Medical Devices, Atomic Energy, Weapons Acts, etc.) more with safety engineering tasks.

Figure 3 gives a survey of the objectives, fields of legal activity and most important tasks of an NMI. In Germany, these tasks are traditionally performed by the PTB (*Physikalisch-Technische Bundesanstalt)* in cooperation with the verification authorities of the German *Bundeslaender* (Federal States); the PTB performs all tasks as head of the country's metrological infrastructure.

## 2.2 International aspects

International cooperation has always played an important role in the activities of NMIs.

The *Bureau International des Poids et Mesures (BIPM)* was founded to contribute to worldwide uniformity and to satisfy resolutions of the Metre Convention. However, BIPM alone cannot guarantee international uniformity of units. It receives support from direct cooperation by NMIs and regional organizations, i.e. by comparison measurements on a regional level (with BIPM as coordinator and/or publisher of results).

The aims and tasks of OIML (International Organization of Legal Metrology) are well known; it has 54 Member States and 42 corresponding members, and runs a voluntary certificate system. Neither the BIPM nor the OIML are accreditation bodies as yet.

ILAC (International Laboratory Accreditation Conference) facilitates and encourages the acceptance of test results from accredited laboratories by means of bilateral and multilateral recognition agreements between laboratory accreditation systems. ILAC will probably

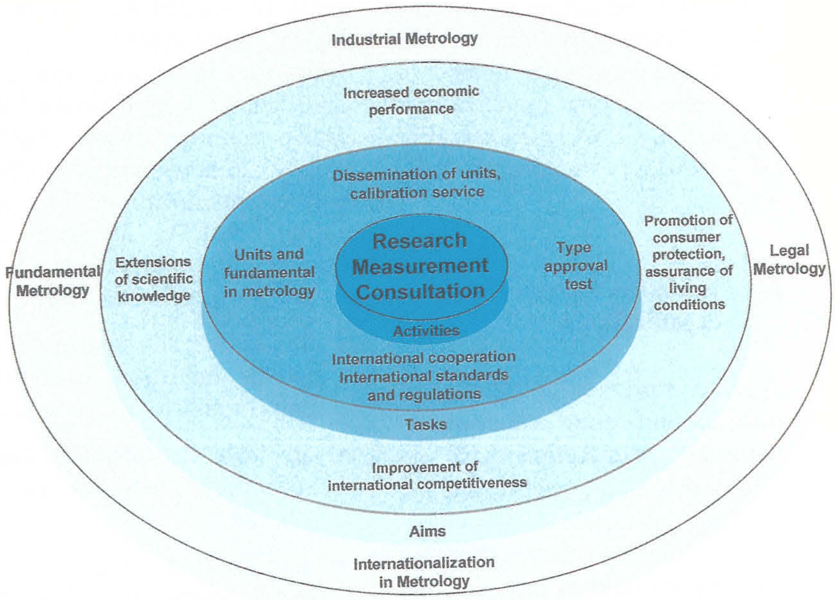



Fig. 2 Aims, activities and major tasks of national metrology institutes in the four areas of metrology.

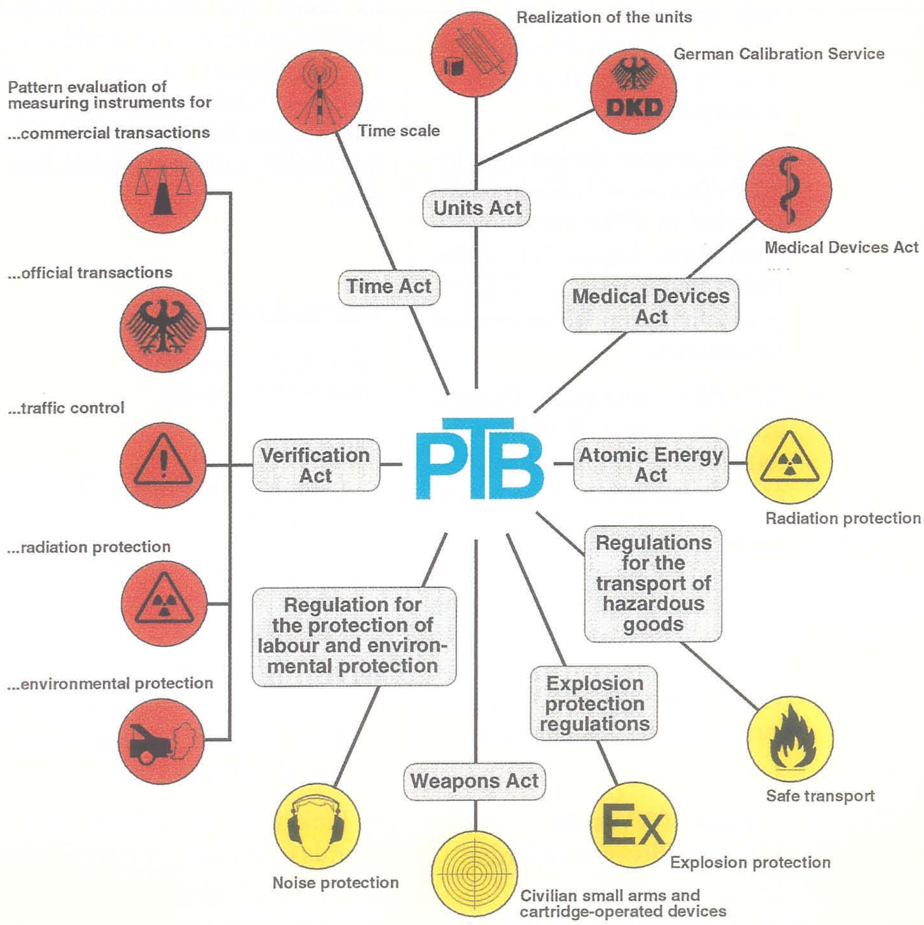



Fig. 3 The legal tasks of PTB.

play a more important role in the future. Delegations from over 40 countries and a growing number of major international organizations (e.g. BIPM, CEN/CENELEC, IEC, ISO, OIML) participate in ILAC work.

### 2.3 European metrological organizations

Together with continuing internationalization, quite a number of regional organizations have recently come into existence, and are in charge of various coordination, cooperation and harmonization tasks in the field of physico-technical metrology. The most important European metrology organizations are:

- EUROMET (European Collaboration in Measurement Standards) - founded in 1987; head of NMI and deputy of EC commission; currently 75 completed agreed projects, 60 projects in preparation;
- EAL (European Cooperation for Accreditation of Laboratories) - founded in 1994; national accreditation bodies for calibration and testing in 17 European countries; 4 000 accredited laboratories;
- WELMEC (European Cooperation in Legal Metrology) - founded in 1989; harmonization and coordination of technical issues in legal metrology;
- COOMET (Organization of national metrological institutions of the states of Central and Eastern Europe) - founded in 1991; deputies of NMIs in former COMECON countries.

### 2.4 Types of NMIs (by availability of standards)

There are more than 220 independent countries in the world which have, or should have, a metrological infrastructure. Existing NMIs vary in facilities and tasks, and then work on different levels. Many countries work together closely within regional economic or political organizations (European Union, NAFTA, Mercosul and others). A country has several options for creating an NMI:

- an NMI for all activities (fundamental, industrial, legal metrology) or only for different parts;
- an NMI for primary and/or secondary standards in one laboratory;
- an NMI that delegates metrological duties to other institutions.

Nowadays, the entire range of metrological tasks can no longer be carried out by individual countries. Therefore, every country, based on its needs and resources, should look for possibilities of establishing a metrological system in cooperation with others. There are several conceivable types of NMIs; five models will be presented hereafter.

#### *NMI Model A*

*All the primary standards are directly accessible.*

Advantages:

- Complete metrological independence.
- Standards meeting highest metrological requirements are permanently available.
- The values of these national standards are independent of those of other national standards of the same kind.
- Link with subordinate standards is ensured.

Disadvantage:

- Extremely high cost.

#### *NMI Model B*

*A selection of primary standards is maintained.*

This alternative offers industry the chance of receiving calibrations for the most significant units at the highest accuracy possible. This is the model for industrialized countries.

Advantages:

- Calibrations for the most significant physical and technical units at the highest accuracy possible.
- Competitiveness is ensured.
- Considerable cost reduction.

Disadvantage:

- Renouncement of complete metrological independence.

#### *NMI Model C*

*Secondary standards are maintained.*

Secondary standards are linked with a primary standard of another country.

Advantages:

- Sufficient calibration options at low cost.
- Specific metrological support of industry possible.
- Little dependence on other countries.

Disadvantages:

- Calibrations of the highest accuracy cannot be performed in one's own country.
- Secondary standards require comparison with the primary standard of another country.

#### *NMI Model D*

*Primary and/or secondary standards are maintained in one or various* *institutions under central administrative supervision.*

A metrological network is based on metrological laboratories located in industrial enterprises and universities under the supervision of an administrative board.

Advantages:

- Calibration possibilities at moderate cost.
- Metrological skills and know-how are accessible where needed and applied.

Disadvantage:

- Decentralization impedes co-operation and exchange of experience between metrological institutions.

*NMI Model E*

*No standards are maintained.*

Advantage:

- Link of reference standards with primary standards of another country at low cost.

Disadvantages:

- Lack of metrological know-how results in dependence on other countries.
- Possibly higher cost for calibration services.
- No guaranteed access to calibration options of other countries and link with a common standard.

Every government must choose the degree of metrological autonomy in each field. Figure 4 shows the current situation in Europe and demonstrates that there is a well-established share of labour at the level of metrology institutes. Only some appropriately equipped NMIs can carry out calibrations at the highest metrological level. In the future, probably only few metrological institutes will be capable of keeping primary standards ready for the majority of physical quantities and carrying out extensive research work. Within a region such as the European Union, the establishment of a metrological network as described in Model D would be conceivable. However, such a project has not been reflected upon as yet.

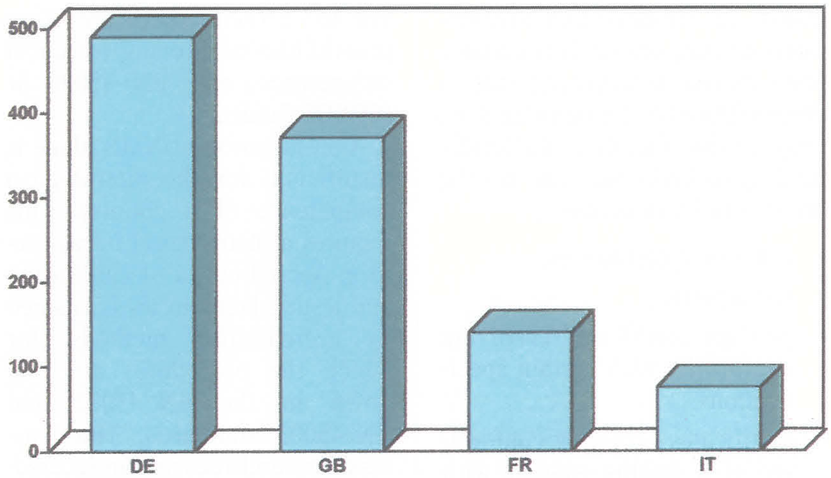



Fig. 4 Calibrations performed by metrological institutes of Germany, Great Britain, France and Italy for applicants from other EUROMET member countries (1990).

## 3 Demonstration of technical competence

Technical competence has a decisive influence on metrological services rendered. Thus, its assessment is of special importance as it can result in the creation of confidence. There are the following measures:

- Demonstration that the NMI meets all the criteria of ISO/IEC Guide 25;
- Participation in international and regional comparison measurements;
- Publication of the results of comparison measurements;
- Participation in the work of corresponding technical committees and workshops.

An NMI must be able to give evidence of its technical competence. Usual methods for this are self-declaration, peer evaluation by experts of other NMIs or a complete accreditation procedure.

Due to the extraordinary role of an NMI for the metrological infrastructure of a country, accreditation shall not be given priority. However, it is essential for the NMI to demonstrate its competence through published results of intercomparisons. These intercomparisons can be carried out by, or under the auspices of, international or regional organizations or by bilateral agreements. "Self-declaration" means that the NMI declares that it complies with relevant standards and it demonstrates this by corresponding documentation.

A speciality is the nomination of competent bodies in a country in the field of legal metrology, which are called "notified bodies". This system is used with harmonized directives in the European Union, especially in the legally controlled field. At this time, there is only one example of this in classical legal metrology: the directive "Non-automatic weighing instruments". Notified bodies are, and must remain, third parties. Their legal status, i.e. whether they are privately or state-owned, is irrelevant. They should, however, be able to demonstrate to the national government that they meet the legally binding criteria set out in the Annexes to EC directives:

- calibration certificates;
- test reports;
- product certificates certifying conformity with certain specifications;
- certificates certifying conformity of a quality system with specified standards.

Some NMIs may wish to supplement this assurance of international consistency by further demonstrations of competence. Some choose to comply with the requirements of ISO 9001 and perhaps seek certification of their Quality System. One should be aware, however, that the certification of a quality system is no substitute for the demonstration of technical competence.

With regard to the problem of accreditation, Table 1 shows the situation in Europe concerning the types of proof of technical competence in various metrological areas. The tendency is to show competence through accreditation for all calibration and testing activities offered to customers. For other activities, ISO 9000 may be the aim. In the authors' opinion, official accreditation for the whole NMI is not considered necessary. For the present, there are other possibilities of proving technical competence, e.g., EN 45000 or ISO/IEC Guide 25.

Consideration of NMIs alone is insufficient for the metrological competence of a country. This requires a metrological infrastructure. Accreditation of calibration and testing laboratories is ensured by accreditation methods, for which the procedures are laid down in the EN 45002 and EN 45003 standards. Thus, assessment and recognition (accreditation) of the technical competence of metrological laboratories play an important role.

The classical accreditation system of "accredited test centres" for testing the measuring instruments for electricity, gas, water and heat has proved successful in Germany since 1902. More than 400 test centres ease the workload of the State with regard to performance of legal tasks. The correctness of test results is ensured by a coordinated system of administrative and technical regulations. Recognition and annual supervision are carried out by verification authorities in close technical cooperation with PTB.

We have compared the requirements contained in the EN 45000 standard series with the relevant regulations for these test centres and have found similar formal aspects.

The primary role of the notified body is to provide the facilities for conformity assessments with the conditions set out in directives as a service for manufacturers and users. Notification is not only a technical decision. It is also a fundamental policy that the decision be made by the competent national authorities. Notification will normally be carried out by the national ministries responsible for the implementation and management of requirements in the directives concerned.

The PTB is notified by the Ministry of Economy, and is responsible for performing type testing related to verification of measuring instruments. For other fields, this is done by other authorities. Table 2 presents the situation in Germany.

## 4 Outlook

The following tendencies in metrological development are perceptible in Europe and perhaps all over the world:

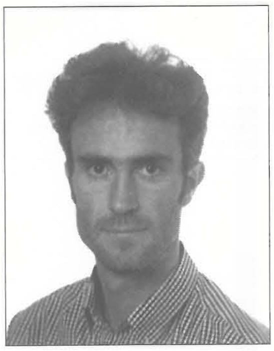
- Increasing cross-border cooperation due to competition or mutual labour sharing;
- Improving transparency of NMI work;
- Fulfilment of the requirements of EN 45000 series standards;
- Increasing privatization of former state tasks;
- Deepening of "metrological consciousness" in industry and testing. ■

Table 1 Types of proof of technical competence in various metrological areas.

| | Fundamental Metrology | Industrial Metrology | Legal Metrology |
|---|---|---|---|
| Self-declaration | x | | (x) |
| Peer evaluation | x | | |
| "Notified body" | | | x |
| Official accreditation | (x) | x | (x) |

Table 2 Use of accreditation systems in metrology: situation in Germany.

| Scope of metrology | Accreditation system |
|---|---|
| Legal metrology | Accredited test centres (since 1902) |
| | "Notified Bodies" (1993) |
| Industrial metrology | DKD (founded in 1977) |
| Research | — |



METROLOGICAL INFRASTRUCTURES

# The Belgian Metrology Service*

**H. PIRÉE,** Industrial Engineer, Belgian Metrology Service

*The Belgian Metrology Service is the official governmental body responsible for industrial and legal metrology, as well as for the accreditation of calibration laboratories. The Service is closely linked with the official Services dealing with the accreditation of testing laboratories, inspection bodies and certification bodies.*

## 1 History

The Belgian State started activities in the field of metrology at an early date of its existence. By 21 August 1816, the decimal metric system was introduced. The first complete law on weights and measures, however, was edicted on 1 October 1855. The activities concerned were limited to instruments used in trade. Agents were appointed by the King in all the provinces of Belgium and charged with verification tasks. The principle of traceability was already introduced since the working standards of the verification officers were to be compared with the standards kept in Brussels.

Belgium was one of the first 18 States who signed the "Meter Convention" in 1875. The first "Central Bureau for Weights and Measures" was established by Royal Decree on 29 April 1904. The Royal Decree charged this Bureau with the following:

1. Custody and reproduction of the national standards and realization of their multiples and submultiples;
2. Periodical verification of working standards;
3. Verification and calibration of measuring instruments.

Through this Decree, the possibility was given to organize the "Bureau" as a laboratory capable of working in areas other than those of the classical instruments used in trade.

## 2 Present legal framework

The law on measuring units, standards and measuring instruments on which the present-day activities of the Metrology Service are based, dates from 16 June 1970. It was necessary to adapt the legal framework in order to follow the metrological progress and to better respond to the needs of society. Indeed, the law of 1855 was restricted to the units and measuring instruments for mass, length, volume and surface.

Although a law from 1903 and a Royal Decree from 1939 gave the possibility to treat other quantities and measuring instruments, a new and coherent law was considered to be the best way to follow the metrological work of the European Commission and Council, and to introduce corresponding Directives into national law.

The law of 16 June 1970 was modified on 21 February 1986 in order to be able to start activities in the field of the accreditation of calibration laboratories.

## 3 Organizational structure

The Metrology Service is a division of the General Direction "Quality and Security" within the Ministry of Economic Affairs. The General Direction "Quality and Security" consists of four divisions: Division I: Quality; Division II: Security; Division III: Technical Competitivity of Enterprises; Division IV: Belgian Geological Service. This structure is shown in Fig. 1.

### The Division "Quality"

The Division "Quality" is divided into three Services: the Accreditation Service, the Central Laboratory, and the Metrology Service.

* *This paper was presented during the "Workshop on Metrology" which was held 13–14 November 1995 in Athens, Greece.*

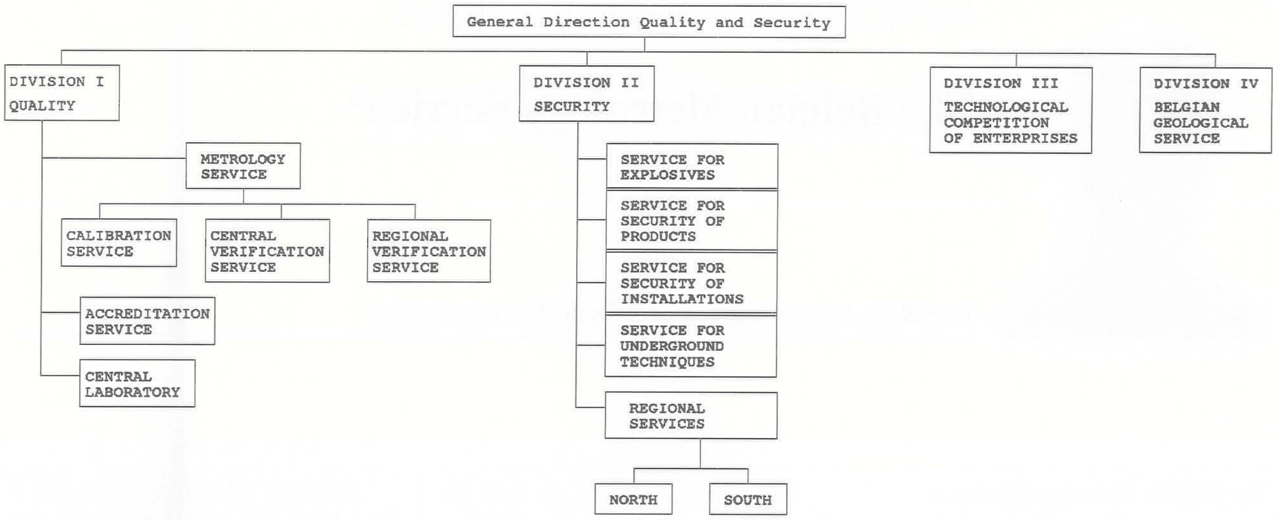



Fig. 1 Organizational structure of the Belgian General Direction "Quality and Security".

*Accreditation Service*

The Accreditation Service is responsible for the development of the accreditation systems BELCERT (Belgian Certification) and BELTEST (Belgian Testing) in order to prove the quality of the Belgian products and services, thus guaranteeing their access to the international market. BELCERT is the organization for the accreditation of certification bodies for quality systems, products and personnel.

*Central Laboratory*

On behalf of the Belgian State, the Central Laboratory performs chemical analysis for food, textile and petroleum products. The laboratory is also responsible for the accreditation of testing laboratories (BELTEST).

*The Metrology Service*

The Metrology Service is active in the fields of industrial metrology and legal metrology. Industrial and scientific metrology deal with the realization and custody of the national standards and the calibration of measuring instruments to ensure the quality of industrial products, research and development.

Legal metrology deals with the drafting of metrological regulations: type approval, initial and periodical verification and technical control of instruments used in trade, public health and public security, as well as the control of prepacked products with respect to mass and volume.

This philosophy is reflected in the structure of the Metrology Service. The three main sections are the Calibration Service (for industrial and scientific metrology), and the Central Verification Service and Regional Verification Service for legal metrology.

The Calibration Service is responsible for mechanical standards and measurements, electrical standards and measurements, physical standards, and measurements and for the Belgian Calibration Organization (accreditation of calibration laboratories).

The Central Verification Service is responsible for legal metrology activities in the field of mass, volume (gas, liquid), length, energy and others.

The Regional Verification Service does the "field work" of legal metrology and is also responsible for the inspection of the mass and volume of prepacked products.

The combination of the Metrology Service, the Accreditation Service and the Central Laboratory within one division will ensure an integrated policy in the fields of quality and security.

## 4 Activities of the Metrology Service

### 4.1 Responsibilities

The law of 16 June 1970 on measuring units, standards and measuring instruments, modified by the law of 21 February 1986, describes the responsibilities and the tasks of the Metrology Service. The most important fields are summarized below:

- Definition of the legal system of measurement units;

- Realization and custody of the national standards;
- Drafting regulations that fix the technical specifications for measuring instruments in legal metrology *(see Fig. 2);*
- Type approval, initial and periodical verification and technical control of instruments used in trade, public health and public security;
- Calibration of standards and measuring instruments used in industry, universities and research centers;
- Accreditation of calibration laboratories;
- Control of prepacked products with respect to mass and volume;
- Collaboration with international organisms like the *Conférence Générale des Poids et Mesures (CGPM),* the *Organisation Internationale de Métrologie Légale (OIML),* EAL, EUROMET, WELMEC, etc.;
- Cooporation with standardization organisms in the field of metrology.

**Legal metrology in Belgium - instruments subject to national control**

- Simple length measures
- Non-liquid volume measures for commercial transactions
- Liquid volume measures for commercial transactions
- Dipsticks
- Medium accuracy weights
- Liquid volume metering instruments for commercial use (petroleum, liquefied petroleum gas, bulk milk, lubricating oil, heating oil)
- Cold water meters
- Gas volume meters
- Electricity meters
- Non-automatic weighing instruments
- Automatic weighing instruments for commercial use (discontinuous totalizing, continuous totalizing [beltweighers], gravimetric filling, rail-weighbridges, catchweighers [checkweighers, weight graders, weigh/price labellers and weigh labellers]
- Law enforcement instruments (chronotachographs [type approval only], ethylometers)
- Road traffic measuring instruments (taximeters, tyre pressure gauges)
- Measuring instruments for grading cereals (no type approval)
- Warm water meters
- Tankers (no type approval)
- Alcoholmeters and areometers for alcohol
- Fixed storage tanks

*Other than where stated, most of the equipment is subject to the full range of type approval, initial verification and mandatory reverification controls.*

Fig. 2 Measuring instruments subject to legal metrology controls in Belgium.

### 4.2 Calibration Service

The Calibration Service consists of three sections:

- Mechanical measurements, with laboratories for mass, density, force, pressure, length and volume;
- Electrical and frequency measurements;
- Physical measurements with laboratories for temperature, humidity and viscosity.

The title for this service is rather misleading since the metrologists not only perform calibration work, but also deal with the national standards in the field of their speciality.

About 15 metrologists and technicians are working in this service. At present, it is not possible to cover all physical quantities due to the limited number of personnel. In order to be able to offer science and industry a set of national standards, as complete as possible, it is planned to associate the Metrology Service with those laboratories which are particularly specialized in one of the missing fields (e.g. ionizing radiation, acoustics, photometry and radiometry). In that way, a national measurement system will be created. The specialized laboratories will be accredited for this purpose by the Ministry of Economic Affairs.

The Calibration Service has been housed in new laboratories for calibration and national standards since June 1995. These laboratories are constructed in such a way that permits all environmental requirements to be met with respect to thermal stability, stability of the humidity of the air, vibrational isolation, etc.

### 4.3 Belgian Calibration Organization (BKO/OBE)

The Belgian Calibration Organization gives a legal system for the accreditation of calibration laboratories. The targets of this system are:

1. to accredit laboratories specialized in the calibration of measuring instruments;
2. to contribute to the development of a metrological network

that can make precise measurements for traders, companies, laboratories, industrialists and scientists;

3. to aim at the international recognition of calibration certificates issued by Belgian accredited calibration laboratories.

The purpose of accreditation is that the accreditation certificate is an official statement of the technical ability of the laboratory and the objectivity of its findings, thus increasing the confidence of economic agents in the services supplied. In addition, without accreditation, it is virtually impossible to be accepted at European and international levels, both in regulated and voluntary sectors.

The accreditation criteria on which the system is based, are laid down in the NBN-EN 45001 standard, and completed by specific BKO/OBE documents complying with the regulations issued by the European Accreditation of Laboratories (EAL).

The accreditation structure is based on the Royal Decree of 28 November 1986 setting up the Belgian Calibration Organization, enacted in accordance with the Law of 16 June 1970 on units, standards and measuring instruments. The structure is as follows:

- a secretariat, managed by the Metrology Service;
- a General Calibration Commission, an interministerial body acting as an accreditation office;
- auditors which are appointed by the General Calibration Commission;
- a high authority which awards the accreditation certificate: the Minister of Economic Affairs.

The Belgian Calibration Organization operates in close co-operation with the accreditation systems BELTEST and BELCERT. By the end of 1995, there were 14 accredited calibration laboratories.

### 4.4 Verification Services

The Verification Services are responsible for the legal part of the Metrology Service. This comprises type approval, initial verification, inspection and reverification, and the control of prepacked products and sanctions.

*Type Approval*

The type approval function is performed by the Metrology Service. Sub-contractor facilities, accredited to EN 45000, are used where testing facilities are not available to the Metrology Service, e.g. EMC testing and the testing of load cells. A published list of type approval costs is available to potential submitters. The Metrology Service's principal workload in EEC certificates is in the approval of cold water meters. For national approvals, its greatest volume is in weighing instruments, non-water liquid flowmeters, electricity and gas volume meters. Certificates are only published in the national languages.

*Initial Verification*

Initial verification of all instruments, except some specialized instruments such as ethylometers, is performed by the regional verification offices of the Metrology Service. There is no system permitting any manufacturer, repairer or installer to self-declare conformity of equipment for nationally approved instruments. For the purposes of 90/384/EEC, the quality systems of manufacturers who wish to perform EC initial verification have to be approved by a notified body (EC declaration of conformity, pt. 2 of annex II of 90/384/EEC). Fees for initial verification are set by law and are available from the Metrology Service in the brochure *"Metrologische Verrichtingen Ijklonen / Opérations Métrologiques Taxes"*.

*Inspection and Reverification*

A mandatory reverification system operates in Belgium. Typical reverification intervals are shown in Table 1.

**Table 1** **Typical reverification intervals for various categories of measuring instruments in Belgium.**

| Measuring instrument | Interval |
|---|---|
| • Trade weights | 4 years |
| • Weighing instruments used in trade | 4 years |
| • Petrol dispensing pumps used in trade | 1 year |
| • Cold water meters | 16 years (8 years if > 10 $m^3/h$) |
| • Tyre pressure gauges | 4 years |
| • Electricity and gas meters | 5 years |
| • Ethylometers | 1 year |
| • Simple length measures | 4 years |
| • Volume measures | 4 years |
| • Measuring instruments for grading cereals | 4 years |
| • Warm water meters | 8 years |

*Control prepacked products*

The Metrology Service also enforces legislation governing prepackages and average quantity, and inspectors are involved in both systems: approval and monitoring. Inspectors provide advice to businesses on legal requirements and are increasingly called upon to give advice on quality assurance and the application of ISO 9000 standards series.

*Sanctions*

Financial penalties may be applied by the courts. There is no system of administrative penalties. Two penalty systems are in operation: one relating to inaccurate equipment, and the other to more serious issues, such as fraud. Only in the latter cases are prosecutions brought to the courts by Government prosecutors. Instruments used fraudulently or found significantly outside inspection tolerances are liable to forfeiture. Instruments found generally outside inspection tolerances may be prohibited from further use pending repair. Emphasis is placed up preventing offences rather than prosecuting, and equipment problems are therefore generally dealt with by way of warnings.

### 4.5 National, European and international cooperation

The Metrology Service participates in the activities of standards bodies, but only with respect to metrology. The participation is organized via the "Belgian Standards Institute" (BIN/IBN) and the "Belgian Electrotechnical Committee" (CEB), being the national members of the corresponding international and European Standards bodies. The Metrology Service also participates in other European and international organizations, as shown in Fig. 3. ■

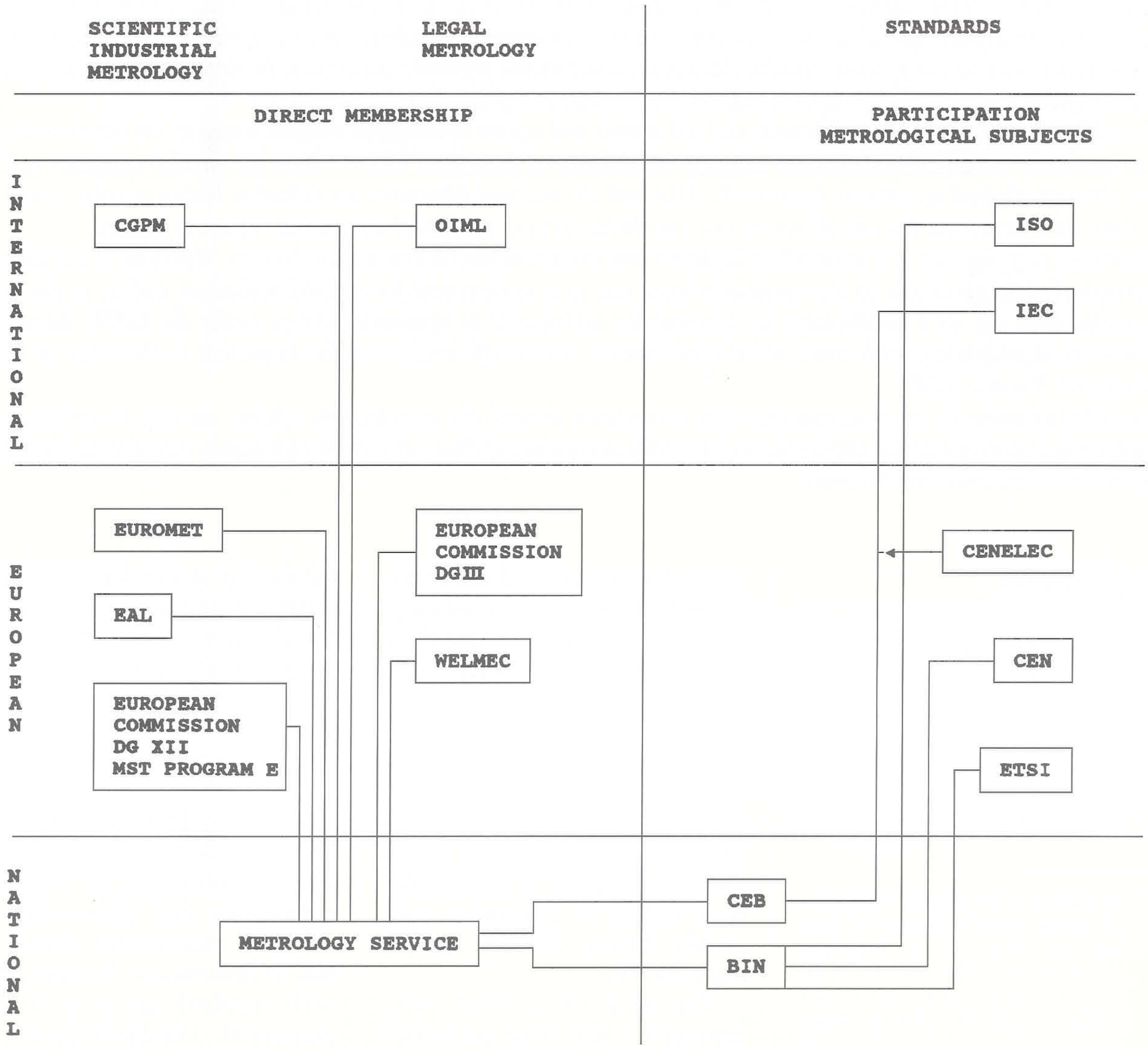



Fig. 3 National, European and international cooperation of the Belgian Metrology Service.

ACCREDITATION

# The accreditation policy of EAL

**R. KAARLS,** President of the European cooperation for Accreditation of Laboratories (EAL)*

*Abstract*

*The European cooperation for Accreditation of Laboratories - EAL was established on May 31, 1994 by the merger of WECC and WELAC. For many reasons an increasing number of laboratories are interested in becoming accredited. Accredited laboratories not only fulfil the ISO 9000 quality assurance criteria, as far as they apply to the laboratory, but more importantly these laboratories have been judged on the basis of the EN 45001/ISO Guide 25 for their claimed technical competence. Special attention is paid to the international traceability of test results and the measurement uncertainties connected to these results. Accredited laboratories regularly participate in (inter-)national laboratory intercomparisons or proficiency tests in order to demonstrate compliance with the claim.*

*The calibration certificates, measurement and test reports and reports of chemical analysis issued by the laboratories are internationally recognized and accepted through the Multilateral Agreement (MLA) within the member countries of EAL and through bilateral agreements between the MLA and the national laboratory accreditation bodies of other countries in those third countries. The establishment of a worldwide network of mutual recognizing regions is fostered.*

*Laboratory accreditation is a powerful and efficient tool in eliminating technical trade barriers. Therefore, it will play an increasingly important role in the mandatory area, e.g. as a requirement for notified bodies, as well as in the non-regulated area, e.g. as a requirement for laboratories taking part in agreement groups under the EOTC. Moreover, laboratory accreditation, with some added requirements, can be efficiently used for inspection in the scope of Good Laboratory Practice (GLP).*

*Accredited laboratories, by demonstrating their competence through the accreditation scheme, are able to reinforce and improve their position in the market through the wide acceptance of their calibration certificates, measurement and test reports and chemical analysis reports.*

## Introduction

The need for standardization of measurements has been accepted internationally for over 100 years. In practice, it has been only during the last 50 years that formal mechanisms have been developed to ensure that the laboratories which disseminate and use measurement standards are competent to perform such work. Before these formal mechanisms existed, companies had set up their own assessment schemes. Although this increased the effectiveness of their purchasing, it did not always provide a measure of the competence of the laboratory, which was also subjected to assessments by a variety of customers, each usually having different quality requirements.

The need for a third party approach which used guidelines and avoided multiple assessment led directly to the development of internationally accepted guidelines for the competence and quality systems of laboratories.

The ISO/IEC Guide 25 was produced to serve this purpose. In 1989, a European standard was generated, EN 45001, which was based upon ISO/IEC Guide 25. These two documents provide the basic requirements for technical competence that laboratories involved in measurement should be able to demonstrate. To ensure that such standards are properly implemented, standards have also been generated for the bodies

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(laboratory accreditation bodies) that assess the laboratories against EN 45001 and ISO/IEC Guide 25. Such accreditation bodies now exist in most European countries. These bodies soon found that they have many problems of mutual interest, not least of which includes the need for mutual recognition of certificates and reports issued by each other. To reach mutually acceptable solutions, two co-operations – WECC and WELAC – were established.

As a result of the further development of the laboratory accreditation schemes and the increased importance of the schemes in society, integration of the calibration and testing laboratory accreditation into one national accreditation scheme became a logical, effective and efficient next step. This is now also reflected in the establishment of EAL by merging WECC and WELAC.

## What is laboratory accreditation?

There often seems to be a lot of misunderstanding with regard to what is meant by laboratory accreditation, recognition, registration, notification and certification. Therefore, we seek to make clear that laboratory accreditation is the formal recognition, authorization and registration of a laboratory that has demonstrated its capability, competence and credibility to carry out the tasks it is claiming to be able to do.

The body granting the formal recognition records the accredited laboratory in a register which is published periodically. The accredited laboratory is authorized to issue calibration certificates, test reports and reports of chemical analysis, which are recognized and accepted under the logo of the (inter-)national laboratory accreditation body.

## Why laboratory accreditation?

There are many reasons for laboratories to opt for accreditation. Depending on the situation, various arguments are valid, all of which should lead to a better position in the market and to an improvement in competitivity. These include:

- external verification of the efficiency, correctness and accuracy of the processes in the laboratory;
- demonstration of quality and technical competence;
- (international) acceptance of certificates, test reports and reports of chemical analysis, issued by the accredited laboratories;
- improved protection against liability;
- fulfilment of customer requirements; and
- fulfilment of national legislation requirements as well as of EC requirements.

## Criteria for accreditation

The criteria which have to be fulfilled by the accredited laboratories are formulated in the written standard EN 45001. These accreditation criteria also include all relevant paragraphs of the ISO 9000 standards (quality system) as far as they apply to laboratories.

A very important aspect of the EN 45001 standard concerns technical competence, i.e. that apart from the quality aspect, the technical competence of the laboratory is also judged. The evaluation process of the laboratory therefore includes a careful consideration of:

- the technical and eventually scientific competence of the laboratory staff,
- the technical capabilities (equipment, facilities),
- the environmental conditions inside and outside the laboratory (temperature and humidity control, vibration, cleanness, electromagnetic interference, etc.),
- the measurement and test procedures, or the procedures used in analytical chemistry and associated with that, the calculation of the measurement uncertainty budget,
- the results of interlaboratory comparisons and proficiency tests.

Where necessary, EAL has published some interpretation documents which give guidance to the laboratories in interpreting the general criteria mentioned in the EN 45001 standard for their special case in the laboratory. The formulation of these interpretation documents has been necessary not only for giving some assistance but also for the sake of uniform judgement of the same types of laboratories by the national accreditation bodies in different countries. This, of course, is needed to treat every laboratory in the same fair way and to prevent the possibility of creating false competition through the system of accreditation.

Because many laboratories do business all over the world, the laboratory assessments carried out by the EAL members also include a verification of the ISO-Guide 25 criteria. Therefore, EAL accredited laboratories not only fulfil the EN 45001 criteria, but also those of ISO-Guide 25.

## European cooperation for Accreditation of Laboratories – EAL

EAL was established on May 31, 1994 in Paris, by the amalgamation of the Western European Calibration Cooperation (WECC) and the Western European Laboratory Accreditation Cooperation (WE-LAC).

WECC was founded in 1975 as a forum for collaboration between the national calibration laboratory accreditation bodies in Western Europe. It included all EC countries, except Luxembourg, and EFTA-countries. The calibration laboratory accreditation system also forms a part of the national metrology system because it is a controlled system for the dissemination of the units from the top (the national metrology institutes) to the workshop floor. Therefore, the calibration laboratory accreditation systems in different countries are part of, or at least closely connected to the national metrology institutes. Over 1 000 calibration laboratories have been accredited to date by the WECC member organizations.

WELAC was founded in 1988 as a forum for collaboration between national testing laboratory accreditation bodies in Western Europe; its members were drawn from the same countries as the WECC membership. The model of the Memorandum of Understanding was taken over from the WECC-MoU. WELAC members have accredited over 3 000 test laboratories in Europe. The laboratory accreditation bodies operate according to the EN 45003 standards and to ISO Guide 58.

Taking into account the fact that laboratories often have activities in calibration as well as in testing, that there is no sharp distinction between calibration and testing (for example, in an analytical laboratory), and that the quality system for calibration and testing is generally the same (as is the criteria), it is clear that for reasons of efficiency, cost reductions, uniformity and transparency, a general movement was observed in recent years to merge the national calibration laboratory accreditation body with the national testing laboratory accreditation body.

This consequently led to the formation of EAL by merging WECC and WELAC. The EAL membership is given in Table 1. The EAL organization is shown in Figure 1.

Table 1 EAL Member Organizations.

| | Calibration | Testing |
|---|---|---|
| Austria | Bundesministerium für Wissenschaftliche Angelegenh, Vienna | Bundesministerium für Wissenschaftliche Angelegenh, Vienna |
| Belgium | Belgische Kalibratie Organisatie BKO, Brussels | Beltest, Brussels |
| Denmark | DANAK, Copenhagen | DANAK, Copenhagen |
| Finland | Centre for Metrology and Accreditation, Finnish Accreditation Service – FINAS, Helsinki | FINAS, Helsinki |
| France | Comité Français d'Accréditation COFRAC, Paris | COFRAC, Paris |
| Germany | Deutscher Kalibrierdienst-DKD, Braunschweig | Deutscher Akkreditierungsrat–DAR, Berlin |
| Greece | Hellenic Organization for Standardization – ELOT, Athens | ELOT, Athens |
| Iceland | Icelandic Bureau of Legal Metrology, National Accreditation Scheme, Reykjavik | Icelandic Bureau of Legal Metrology, National Accreditation Scheme, Reykjavik |
| Ireland | National Accreditation Board, Ballsbridge, Dublin | National Accreditation Board, Ballsbridge, Dublin |
| Italy | SIT, Torino | SINAL, Rome |
| Netherlands | Raad voor Accreditatie – RvA, Utrecht | Raad voor Accreditatie – RvA, Utrecht |
| Norway | National Measurement Service, Oslo | National Measurement Service, Oslo |
| Portugal | Istituto Português de Qualidade – IPQ, Monte da Caparica, Lisbon | IPQ, Monte da Caparica, Lisbon |
| Spain | ENAC, Madrid | ENAC, Madrid |
| Sweden | SWEDAC, Borås | SWEDAC, Borås |
| Switzerland | Swiss Accreditation Service – SAS, Wabern, Bern | SAS, Wabern, Bern |
| United Kingdom | UKAS, Teddington | UKAS, Teddington |

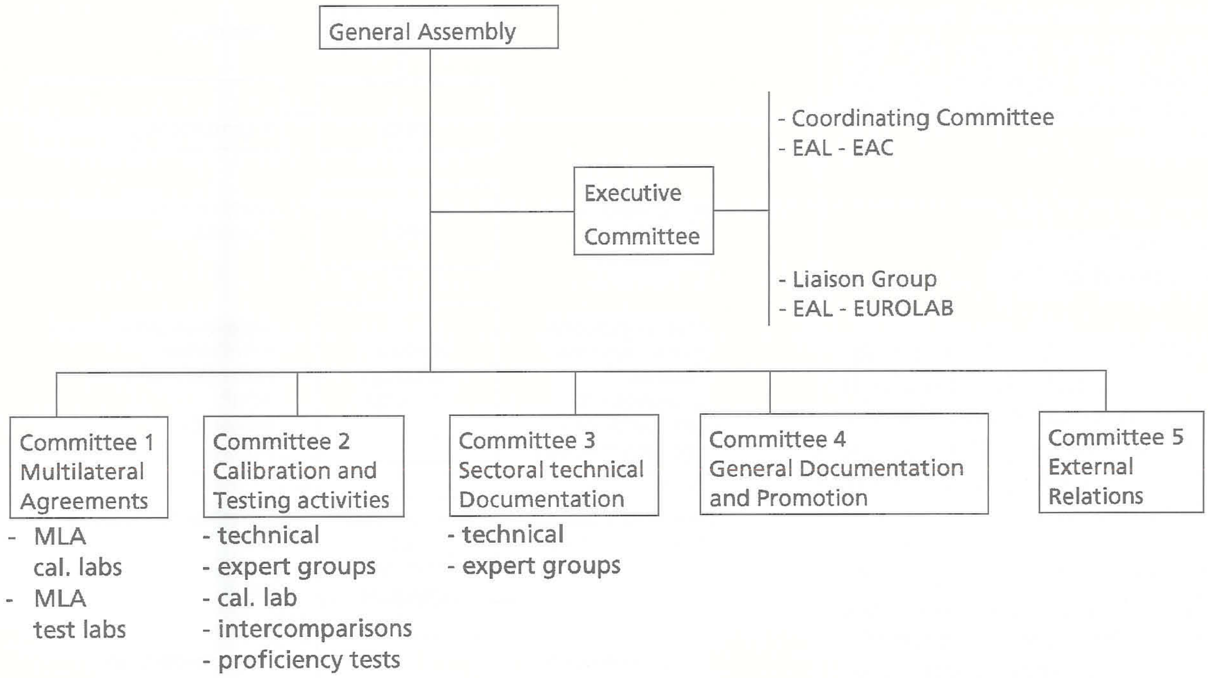



Fig. 1 The organization of EAL.

## Multilateral agreements of mutual equivalence and recognition

International trade benefits highly when test reports issued by an (accredited) laboratory are accepted elsewhere. This, however, works only when the customer has confidence in the laboratory carrying out the test and issuing the report. The system aims at establishing this confidence in technical competence, impartiality and quality assurance.

In addition, bodies which are responsible for fair trade, health, safety and environmental regulation must have confidence that the laboratories conducting the associate testing and calibration are competent and that their results are valid. The completion of the Single European Market and the progressive enlargement of the union has accelerated the need to dismantle technical barriers to trade which result from a lack of acceptance of the test results produced in one country by the customer or authorities in another.

The multilateral agreement of mutual equivalence and acceptance has now become the vehicle for overcoming these problems. The agreement is based on an international peer evaluation by an international assessment team, existing of accreditation experts in quality assurance, as well as experts in different technical fields. This assessment team visits the national accreditation body under scrutiny generally during one week. The team looks into the functioning of the accreditation body itself, visits some accredited laboratories and looks into the results of international laboratory intercomparisons and proficiency tests. Whether the national system fulfils the EN 45001–3 standards and the EAL interpretation and harmonization documents is verified at the assessment.

When the international assessment is concluded successfully, that member organization becomes a signatory to the multilateral agreement. This means that the calibration, test reports and reports of chemical analysis issued by the accredited laboratories under that member organization are recognized and accepted by the other countries of which the accreditation bodies are a signatory to the MLA. The international assessments are carried out systematically and repeated once every four years.

At present, there exists two EAL multilateral agreements: one for the field of calibration and one for the field of testing. Both MLA's have been signed by the calibration laboratory accreditation bodies of 12 member countries: Denmark, (DK), Ireland (EI), Germany (DE), Finland (FI), France (FR), Italy (IT), the Netherlands (NL), Norway (NO), Spain (ES), Sweden (SE), Switzerland (CH) and the United Kingdom (UK).

It is expected that in the near future, three more member countries will become signatories to the multilateral agreement. Therefore, under the two MLA's, a total of almost 5 000 laboratories have been accredited.

Every year, the national accreditation bodies publish all the accredited laboratories with information as to the areas for which they have been accredited, the measuring and test ranges, the best measurement capabilities and the names of the authorized staff of the laboratory.

## Important topics addressed by EAL

In order to create confidence in the system of accredited laboratories, it is of utmost importance that the customer and the authorities be able to trust the outcome of the calibration, test and analytical laboratories. Therefore, not only must full attention be given to the existence of a quality assurance system, but more importantly, accreditation must create confidence in the technical competence and the international traceability of the test results with its associated measurement uncertainty statement.

*Traceability*

One condition for EAL membership is that a country has an internationally accepted national metrology system in place. The national metrology institute also has to demonstrate, on the basis of results of international comparisons, where it stands with respect to its international traceability. Clearly, it is for these reasons that close connections exist between the national metrology institutes and the national laboratory accreditation bodies. These international comparisons on the highest metrological level are carried out under the *Bureau International des Poids et Mesures (BIPM)*, EUROMET, EURACHEM and sometimes on a bilateral basis. The metrological chain and infrastructure is given in Fig. 2.

Traceability is the property of the result of a measurement or a test, or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons which all have stated uncertainties.

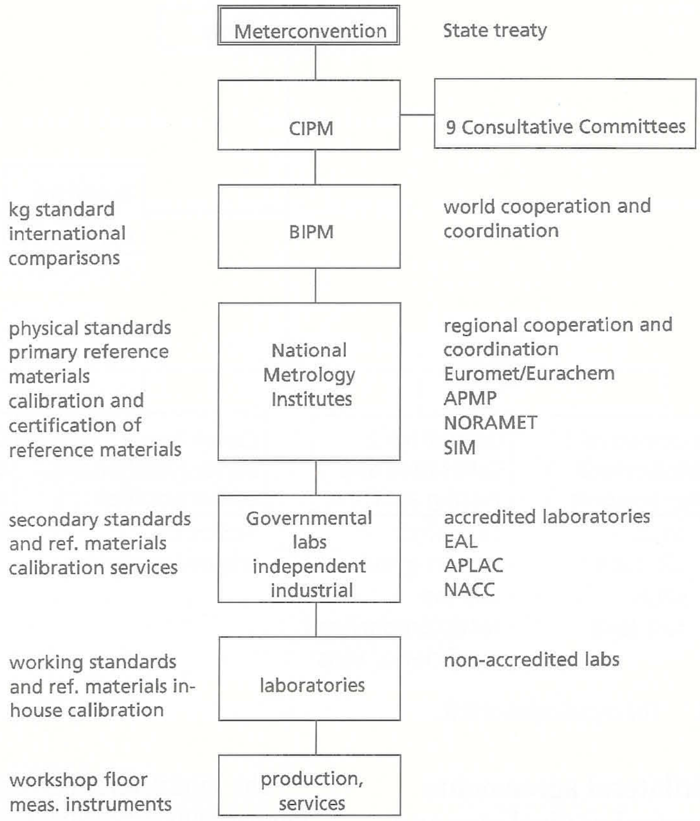



Fig. 2 Metrological chain and infrastructure.

In the field of physical measurements, significant progress has been made over the last decennia in establishing and improving international traceability. However, in many areas of testing, and certainly in the field of chemical analysis, the situation is not at all satisfactory and much work remains to be done to improve international comparability and traceability of test results and results of chemical analysis. The situation will only be satisfactory when an identical sample analyzed by an accredited laboratory in one country leads to the same result when analyzed by an accredited laboratory in another country.

EAL, together with the BIPM, EUROMET and EURACHEM, fosters the rapid development of a worldwide traceability scheme for chemical analysis. The Consultative Committee for the Amount of Substance (established in 1994), which operates under the Meter Convention, agreed during its first meeting in April 1995 on a series of first steps to realize international traceability in the field of analytical chemistry.

*Measurement uncertainty*

Related to the production of measurement and test results is the concept of measurement uncertainty. Basic ideas on the treatment of measurement uncertainty were developed by a working party established by the International Committee for Weights and Measures in 1981. Based on this, WECC developed guidelines for the expression of the uncertainty of measurement in calibrations (WECC document 19-1990, which is being revised at present).

A more basic document on this topic was published in 1993 by the BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML under the title *Guide to the Expression of Uncertainty in Measurement.* The basic idea behind the concept is that all components contributing to the overall uncertainty can and should be expressed in terms of a standard deviation or variance. In its most simple form,

$$S_y^2 = \sum_{i=1}^{n} S_{x_i}^2$$

where $S_y$ is the combined uncertainty.

Therefore, the result of a measurement is (y ± u) where $u = k \times S_y$ and is called the expanded uncertainty. It has been agreed within EAL that the number 2 is to be taken for k, so $u = 2 \times S_y$, thus approximating a 95 % confidence interval. The factor k = 2 should always be indicated together with the result of a measurement.

For application in chemical laboratories, EURACHEM published in 1995 a *Guide on Quantifying Uncertainty in Analytical Measurement*, giving several examples for chemical analysis and based on the same principles.

*Interlaboratory comparisons or proficiency testing*

A very powerful tool for creating confidence is demonstrating that identical samples sent to different accredited laboratories which claim that they can analyze the same type of samples, result in the same correct answer with regard to test results.

On a national scale, the accreditation bodies therefore have to organize several proficiency tests. On the international scale, EAL will organize these intercomparisons or proficiency tests. In the field of calibration, intercomparisons are mainly organized and carried out by the accreditation bodies themselves with the assistance of the national metrology institutes.

In the field of testing and chemical analysis the accreditation bodies will also make use of proficiency testing schemes of third parties, assuming that the organizers have been accredited for the organization of proficiency testing and assuming that the schemes used have been validated.

*Technical harmonization and interpretation documents*

As already mentioned, EAL will give guidance in how to measure, how to validate, how to calculate measurement uncertainty, how to interpret the official standards and how to assess. These harmonization and interpretation documents have been, and will always be composed in close cooperation with the experts in the field. The technical committees, working parties and task forces working under or on behalf of EAL, closely cooperate with the national metrology institutes and key-laboratories in the field of chemical measurements and testing. Internationally, this means close cooperation with EUROMET, EURACHEM and EUROLAB among others.

Through all these measures, EAL will realize a system of accredited laboratories which will produce reliable calibration, test and analysis results. This, of course, will make all the difference with an ISO 9000 certification, which focuses mainly on the quality assurance system and only looks marginally to the technical competence.

*Training and expertise*

EAL makes use of well-trained assessors and knowledgeable experts. The international harmonization and common interpretation of the criteria is realized through training courses given by different national laboratory accreditation bodies, and by the exchange and participation of assessors in other countries.

The majority of the experts, which are hired ad hoc from the laboratories and who participate in the assessments, have followed courses in the assessment of laboratories. Many of these experts also contribute to the organization of intercomparisons and proficiency tests, discuss the difficulties faced in the intercomparisons, and participate in the writing of technical harmonization and guideline documents. Through this international cooperation and involvement of the laboratory field experts, it has been possible for EAL to react quickly when problems arise and to come up with acceptable solutions within the laboratory community.

## EAL and Eastern Europe

When WECC and WELAC were established, only cooperation in the Western European arena could be discussed. Since then, however, the situation has changed considerably and clearly, the political and trade relations map now looks completely different. Therefore, EAL has re-adapted its Memorandum of Understanding in such a way that laboratory accreditation bodies in Central and Eastern Europe can also become members, first as associate members, which can be considered as an intermediate step towards full membership. It is considered that full membership can be granted when the relationship between that Central or Eastern European country and the EU is converted to a tight and clear relationship or even full EU-membership.

The conditions on laboratory accreditation bodies of Central or

Eastern European countries for (associate) membership are:

- compliance with the EN 45000 series of standards and the EAL criteria;
- existence of an operational accreditation system, and
- existence of a transparent and internationally recognized metrological traceability.

The Czech laboratory accreditation scheme was admitted in the beginning of 1995 as the first associate member of Central Europe. The laboratory accreditation system of the Slovak Republic and the calibration laboratory accreditation system of Hungary were admitted in November 1995. Of course, associate members can become signatories to the EAL-MLA.

## EAL and other countries / regions in the world

Because many laboratories work not only for a national or European market, but have customers outside Europe, EAL has concluded bilateral agreements of mutual equivalence and recognition with the national laboratory accreditation bodies of a few other countries outside Europe. Such a bilateral agreement between the signatories of the MLA of EAL and the accreditation body of another country is signed only after an international assessment has been carried out in the same way as within Europe.

International traceability at the level of national metrology institutes, as well as that of the accredited laboratories, has to be demonstrated by the results of intercomparisons. When an agreement can be signed, mutual rights and duties between EAL and the other body are drawn up in a contract signed by both sides.

By the end of 1995, EAL had signed contracts and agreements with the South African National Calibration Scheme (SANCS), and with the laboratory accreditation bodies in the field of testing and calibration of Australia (NATA), in the field of testing only of New Zealand (TELARC) and Hong Kong (HOKLAS). Evaluations and discussions on possible evaluations are underway with, among others, the United States of America, Canada, Israel, Singapore and some other Asian countries.

It has been agreed within EAL that only EAL will establish agreements between its MLA and the accreditation bodies of other countries, i.e. EAL members will not conclude bilateral agreements between themselves and others. The long-term policy of EAL, however, is to foster the development of a regional approach to other areas in the world for reasons of logistics (e.g. in intercomparisons and international assessments) and for reasons of effectiveness, efficiency and limitations of costs. The result will be the establishment of bilateral agreements between the different regional multilateral agreements. At present, there are two other regional organizations:

- for the Asian Pacific RIM (including almost all countries from Australia - New Zealand to China - Japan) the Asian Pacific Laboratory Accreditation Cooperation - APLAC has been established;
- for North America (Canada, Mexico and the USA), the North American Calibration Cooperation (NACC) has been established.

In South America, initial discussions have been launched to establish a South American laboratory accreditation cooperation. In the end, this will lead to a worldwide network of bilateral agreements between the regional MLAs. The International Laboratory Accreditation Conference (ILAC) can then function as the worldwide coordinating body in the field. Therefore, ILAC is now being transformed into a more institutionalized body.

## EAL cooperation with other organizations

It is clear that EAL functions in close cooperation with many other bodies. To mention:

- European Commission and the EFTA secretariat in support of their policies;
- European Organization for Testing and Certification (EOTC), where EAL acts as the "technical arm" of EOTC;
- EUROMET and EURACHEM, which give the necessary scientific and technical support to EAL, in particular with respect to international traceability;
- EUROLAB, which also gives technical support, being an European association of laboratories and by that, the representative of the customers of the EAL members;
- branch-oriented groupings, like ECITC as the representative organization of the information technology and communications branch;
- CEN/CENELEC/ETSI and ISO/IEC.

## EAL and EAC

The European cooperation for the Accreditation of Certification bodies (EAC) was established recently, following the same model as WECC and EAL.

Since the general trend in the world is to create one national accreditation body per country, it is predictable that a future merger of

EAL and EAC will take place, thereby establishing one European Accreditation organization - EA. Such a merger would also solve problems arising from overlapping situations which exist with the accreditation of inspection bodies (EN 45004), the accreditation of notified bodies and with the accreditation of product certification bodies (EN 45012) where, next to ISO 9000 activities, laboratory accreditation also plays a role.

In order to prepare for the future, EAL and EAC have established a Coordinating Committee which is in charge of harmonizing the various procedures used by EAL and EAC, and formulating a common EAL-EAC policy.

A common accreditation logo is also being prepared in order to be used by the accredited laboratories, inspection bodies and certification bodies. However, the use of this logo will be bound to strict rules which clearly distinguish between the different fields of accreditation. Furthermore, this logo will not be used on products in the scope of product-certification.

## GLP and laboratory accreditation

Many chemical testing laboratories are not only confronted with laboratory accreditation, but have also to fulfil requirements in the scope of Good Laboratory Practice (GLP). It is clear that those laboratories are wondering whether the GLP inspection and the laboratory accreditation can be harmonized and combined. Indeed, several studies by EURACHEM and others have shown that there are no principle differences between the EN 45001 and GLP-requirements. This means that there is no ground for maintaining two different schemes which present twice the necessary costs to society (the tax-payer) and to the industries and laboratories concerned, by maintaining two independent schemes.

Without taking away certain responsibilities which may remain with the authorities responsible for the surveillance of food, drugs, cosmetics, etc., it must be possible to combine the two schemes into one accreditation exercise. Therefore, EAL is devoted to realizing a system for the accreditation of testing laboratories of non-clinical chemicals which takes into consideration special GLP-requirements in addition to the general laboratory accreditation requirements for this type of laboratory. A more efficient system could thus be maintained at considerably reduced costs.

## Expected developments

The system of internationally recognized accredited laboratories is expected to grow further in the near future. In an increasing number of countries, the authorities require laboratories to carry out tests in the regulatory field, e.g. in the field of environmental metrology, to become accredited by the national laboratory accreditation body.

It is also clear that laboratories appointed as notified bodies can only demonstrate their fulfilment of the EN 45000 standards by being accredited. The same applies for laboratories which participate in an agreement group in the scope of the EOTC.

It is also expected that only accredited laboratories will become authorized as laboratories carrying out tests on the basis of legislation in third countries outside the EU. Therefore, only accredited laboratories may be mentioned as authorized laboratories on the lists in the annexes to the Mutual Recognition Agreements for trade relations between the EU and third countries like Australia, New Zealand, USA, Canada and Japan.

## Conclusion

Accreditation of laboratories creates a transparent situation in the world of quality assurance. It is a powerful tool in developing and establishing confidence and credibility between parties in the market. Accreditation is thereby essential for eliminating technical trade barriers in international trade, and is a prime condition for the operation of internal markets.

Moreover, it is an effective and efficient system because it can be fully self-financed. The internationally recognized accreditation system based on an MLA reduces the costs for the laboratory itself: since only one accreditation exercise is carried out, multiple assessment visits and technical audits are avoided. The costs of the accreditation body and indirectly, again, the cost for the laboratories are reduced by having less international assessments.

The condition is that the laboratory accreditation system "guarantees" the correctness, reliability and traceability of the results of measurements, tests and analyses carried out by the accredited laboratories. Therefore, even more attention than in the past has to be given to the judgement and demonstration of the technical competence of the laboratories. ■

### References


[1] EN 45001

[2] ISO/IEC Guide 25

[3] International Vocabulary of basic and general terms in metrology (VIM): BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, (1993).

[4] Kaarls, R (1981) BIPM Recommendation, Proc. Verb. CIPM 49.

[5] Guide to the Expression of Uncertainty in Measurement: BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, (1993).

[6] Guide on Quantifying Uncertainty in Analytical Measurement: EURACHEM (1995).

activities
OIML
activités

# OIML technical activities

## 1995 Review
## 1996 Forecasts

The information given on pp. 47–53 is based on 1995 annual reports submitted by OIML secretariats. Work projects are listed for each **active** technical committee and subcommittee, together with the state of progress at the end of 1995 and projections for 1996, where appropriate.

# Activités techniques de l'OIML

## Rapport 1995
## Prévisions 1996

Les informations données en pages 47 à 53 sont basées sur les rapports annuels de 1995, fournis par les secrétariats OIML. Les thèmes de travail sont donnés pour chaque comité technique ou sous-comité **actif** avec l'état d'avancement à la fin de 1995 et les prévisions pour 1996, si approprié.

### KEY TO ABBREVIATIONS USED

**WD** Working draft (Preparatory stage)
*Projet de travail (Stade de préparation)*

**CD** Committee draft (Committee stage)
*Projet de comité (Stade de comité)*

**DR/DD** Draft Recommendation/Document (Approval stage)
*Projet de Recommandation/Document (Stade d'approbation)*

**Vote** CIML postal vote on the draft
*Vote postal CIML sur le projet*

**Appr.** Approval or submission to CIML/Conference for approval
*Approbation ou présentation pour approbation par CIML/Conférence*

**R/D** International Recommendation/Document (Publication stage)
For availability: see list of publications
*Recommandation/Document International (Stade de publication)*
*Pour disponibilité: voir liste des publications*

| OIML TECHNICAL ACTIVITIES | 1995 | 1996 |
|---|---|---|
| **TC 1 Terminology** | | |
| • Revision V 1: Vocabulary of legal metrology | 1 CD | 2 CD |
| **TC 2 Units of measurement** | | |
| • Revision D 2: Legal units of measurement | 3 CD | DD |
| **TC 3/SC 1 Pattern approval and verification** | | |
| • Initial verification of measuring instruments utilizing the manufacturer's quality system | 2 CD | DD |
| • Revision D 3: Legal qualification of measuring instruments and inclusion in its text the existing D 19 and D 20 | – | 1 CD |
| **TC 3/SC 2 Metrological supervision** | | |
| • Revision D 9: Principles of metrological supervision | WD | 1 CD |
| **TC 4 Measurement standards and calibration and verification devices** | | |
| • Principles for the selection and expression of metrological characteristics of standards and devices used for calibration and verification | – | WD |
| • Revision D 5: Principles for the establishment of hierarchy schemes for measuring instruments | WD | 1 CD |
| • Revision D 10: Recalibration intervals of measurement standards and calibration devices | – | WD |
| • Revision D 6 + D 8: Measurement standards. Requirements and documentation | WD | 1 CD |
| **TC 3 Metrological control – TC 4 Measurement standards and calibration and verification devices** | | |
| • Uncertainty in legal metrology measurements | – | WD |
| **TC 6 Prepackaged products** | | |
| • Revision R 79: Information on package labels | DR | Vote appr. |
| • Revision R 87: Net content in packages | – | 1 CD |

| OIML TECHNICAL ACTIVITIES | 1995 | 1996 |
|---|---|---|
| **TC 7/SC 1 Measuring instruments for length** | | |
| • Revision R 30: End standards of length (gauge blocks) | – | WD |
| **TC 7/SC 3 Measurement of areas** | | |
| Instruments for measuring the areas of leather | 5 CD | 5 CD |
| **TC 7/SC 4 Measuring instruments for road traffic** | | |
| • Electronic taximeters | – | WD |
| • Revision R 55: Speedometers, mechanical odometers and chronotachographs for motor vehicles. Metrological regulations | 3 CD | Vote |
| **TC 7/SC 5 Dimensional measuring instruments** | | |
| • Multi-dimensional measuring instruments | 1 CD | 2 CD |
| • Test report format for the evaluation of multi-dimensional measuring instruments | 1 CD | 2 CD |
| **TC 8 Measurement of quantities of fluids** | | |
| • Standard capacity measures for testing measuring systems for liquids other than water - R 120 | – | R |
| • Pipe provers for testing measuring systems for liquids other than water - R 119 | – | R |
| • Vortex meters used in measuring systems for fluids- D 25 | Appr. | D |
| • Laboratory volume measures - Automatic pipettes - D 26 | Appr. | D |
| **TC 8/SC 1 Static volume measurement** | | |
| • Revision R 85: Automatic level gauges for measuring the level of liquid in fixed storage tanks | CD | DR |
| **TC 8/SC 2 Static mass measurement** | | |
| • Mass measuring systems for liquids in tanks | 5 CD | DR |
| **TC 8/SC 3 Dynamic volume measurement (liquids other than water)** | | |
| • Measuring systems for liquids other than water - R 117 (Revision R 5, R 27, R 57, R 67, R 77) | R | – |
| • Testing procedures and test report format for pattern evaluation of fuel dispensers for motor vehicles - R 118 | R | – |

| OIML TECHNICAL ACTIVITIES | 1995 | 1996 |
| --- | --- | --- |
| **TC 8/SC 4 Dynamic mass measurement (liquids other than water)** | | |
| • Annex to R 105: Test report format for the evaluation of direct mass flow measuring systems for quantities of liquids | R | – |
| **TC 8/SC 5 Water meters** | | |
| • Revision R 49: Water meters intended for the metering of cold water | DR | Vote appr. |
| **TC 8/SC 6 Measurement of cryogenic liquids** | | |
| • Revision R 81: Measuring devices and measuring systems for cryogenic liquids (including tables of density for liquid argon, helium, hydrogen, nitrogen and oxygen) | 2 CD | 3 CD |
| **TC 8/SC 8 Gas meters** | | |
| • Revision R 6: General provisions for gas volume meters | WD | 1 CD |
| • Revision R 31: Diaphragm gas meters | R | – |
| • Revision R 32: Rotary piston gas meters and turbine gas meters | WD | WD |
| **TC 9 Instruments for measuring mass and density** | | |
| • Revision R 60: Metrological regulation for load cells | 1 CD | 2 CD |
| **TC 9/SC 1 Nonautomatic weighing instruments** | | |
| • Revision R 76-1: Nonautomatic weighing instruments | – | 1 CD |
| **TC 9/SC 2 Automatic weighing instruments** | | |
| • Annex to R 50: Test procedures and test report format for the evaluation of continuous totalizing automatic weighing instruments | 3 CD | DR |
| • Revision R 51: Automatic catchweighing instruments (including test procedures and test report format) | Appr. | R |
| • Revision R 61: Automatic gravimetric filling instruments (including test procedures and test report format) | Appr. | R |
| • Annex to R 106: Test procedures and test report format for the evaluation of automatic rail-weighbridges | Appr. | R |
| • Annex to R 107: Test procedures and test report format for the evaluation of discontinuous totalizing automatic weighing instruments | R | R |
| • Automatic road weighbridges | WD | 1 CD |

| OIML TECHNICAL ACTIVITIES | 1995 | 1996 |
|---|---|---|
| **TC 9/SC 3 Weights** | | |
| • Annex to R 111: Test procedures and test report format for the evaluation of weights of classes $E_1$, $E_2$, $F_1$, $F_2$, $M_1$, $M_2$, $M_3$ | **WD** | **1 CD** |
| **TC 10/SC 2 Pressure gauges with elastic sensing elements** | | |
| • Pressure transmitters with elastic sensing elements | **WD** | **WD** |
| • Annex to R 101: Test procedures and test report format for the evaluation of indicating and recording pressure gauges, vacuum gauges and pressure vacuum gauges with elastic sensing elements (ordinary instruments) | **CD** | **DR** |
| • Annex to R 109: Test procedures and test report format for the evaluation of pressure gauges and vacuum gauges with elastic sensing elements (standard instruments) | **CD** | **DR** |
| **TC 10/SC 4 Material testing machines** | | |
| • Requirements for force measuring instruments for verifying materials testing machines | **WD** | **1 CD** |
| • Force measuring systems of materials testing machines (Revision R 64: General requirements for materials testing machines + Revision R 65: Requirements for machines for tension and compression testing of materials) | **DR** | **DR** Vote |
| **TC 10/SC 5 Hardness standardized blocks and hardness testing machines** | | |
| • International intercomparison of hardness blocks (Rockwell hardness blocks) | – | **Plan for inter-comparison** |
| **TC 10/SC 6 Strain gauges** | | |
| • Revision R 62: Performance characteristics of metallic resistance strain gauges | – | **WD** |
| **TC 11 Instruments for measuring temperature and associated quantities** | | |
| • Revision R 75: Heat meters | – | **WD** |
| **TC 11/SC 1 Resistance thermometers** | | |
| • Revision R 84: Resistance-thermometers sensors made of platinum, copper or nickel (for industrial and commercial use) and inclusion of metallic electrical platinum, copper and nickel resistance thermometers with extended range | **WD** | **1 CD** |

| OIML TECHNICAL ACTIVITIES | 1995 | 1996 |
|---|---|---|
| **TC 11/SC 2 Contact thermometers** | | |
| • Standardized thermometers | **WD** | **1 CD** |
| • Liquid-in-glass thermometers | **1 CD** | **2 CD** |
| **TC 11/SC 3 Radiation thermometers** | | |
| • Revision R 18: Visual disappearing filament pyrometers | **WD** | **CD** |
| • Revision R 48: Tungsten ribbon lamps for calibration of optical pyrometers | **WD** | **CD** |
| **TC 13 Measuring instruments for acoustics and vibration** | | |
| • Revision R 58 including development of Annex: Test report format for the evaluation of sound level meters | **DR** | **Vote Appr.** |
| • Revision R 88 including development of Annex: Test report format for the evaluation of integrating-averaging sound level meters | **DR** | **Vote Appr.** |
| • Annex to R 102: Test procedures and test report format for the evaluation of sound calibrators | **R** | **–** |
| • Annex to R 104: Test report format for the evaluation of pure-tone audiometers | **Vote Appr.** | **R** |
| • Equipment for speech audiometry - R 122 | **R** | **R** |
| • Annexes to R 122: Test procedures and test report format for the evaluation of equipment for speech audiometry | **WD** | **WD** |
| • Octave-band and fractional octave-band filters | **1 CD** | **2 CD** |
| **TC 14 Measuring instruments used for optics** | | |
| • Annex to R 93: Test report format for focimeters | **2 CD** | **DR** |
| **TC 15 Measuring instruments for ionizing radiations** | | |
| • Radiochromic film dosimetry system for measuring absorbed dose in products from gamma and electron radiation | **2 CD** | **3 CD** |
| **TC 16/SC 1 Air pollution** | | |
| • Revision R 99: Instruments for measuring vehicle exhaust emissions | **1 CD** | **2 CD** |

| OIML TECHNICAL ACTIVITIES | 1995 | 1996 |
| --- | --- | --- |
| **TC 16/SC 2 Water pollution** | | |
| • Inductively coupled plasma atomic emission spectrometers for measurement of metal pollutants in water - R 116 | **R** | **–** |
| • Revision R 83: Gas chromatograph - mass spectrometer | **WD** | **1 CD** |
| • Revision R 100: Atomic absorption spectrometers for measuring metal pollutants in water | **WD** | **1 CD** |
| **TC 16/SC 3 Pesticides and other toxic substances pollutants** | | |
| • Revision R 82: Gas chromatographs for measuring pollution from pesticides and other toxic substances | **–** | **WD** |
| **TC 16/SC 4 Field measurements of hazardous (toxic) pollutants** | | |
| • Portable and transportable X-ray fluorescence spectrometers for field measurement of hazardous elemental pollutants | **Vote Appr.** | **R** |
| • Air sampling devices for toxic chemical pollutants at hazardous waste sites | **WD** | **1 CD** |
| • Fourier transform infrared spectrometers for measurement of hazardous chemical products | **WD** | **1 CD** |
| **TC 17/SC 1 Humidity** | | |
| • The scale of relative humidity of air certified against saturated salt solutions – R 121 | **R** | **R** |
| **TC 17/SC 2 Saccharimetry** | | |
| • Revision R 14: Polarimetric saccharimeters | **R** | **–** |
| • Refractometers for measuring the sugar content of grap must | **CD** | **Vote Appr.** |
| **TC 17/SC 3 pH-metry** | | |
| • Revision R 54: pH-scale for aqueous solutions | **DR** | **Vote Appr.** |
| • Method of carrying out pH-measurements. Certification methods of solutions for verification of pH-meters | **CD** | **DR** |
| **TC 17/SC 4 Conductometry** | | |
| • Methods of measurement of the conductivity of electrolytic solutions | **WD** | **1 CD** |
| • Hierarchy scheme for instruments measuring the electrolytic conductivity | **WD** | **1 CD** |

| OIML TECHNICAL ACTIVITIES | 1995 | 1996 |
|---|---|---|
| **TC 17/SC 5 Viscometry** | | |
| • Newtonian viscosity standard specimens for the calibration and verification of viscometers | CD | CD |
| • Procedure for the kinematic viscosity measurements by means of standard viscometers | 2 CD | DR |
| **TC 17/SC 6 Gas analysis** | | |
| • Revision R 73: 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 | WD | 1 CD |
| **TC 17/SC 7 Breath testers** | | |
| • Evidential breath analyzers | DR | Vote Appr. |
| **TC 18 Medical measuring instruments** | | |
| • Ergometers for foot crank work: definitions, requirements, tests | 1 CD | 2 CD |
| **TC 18/SC 1 Blood pressure instruments** | | |
| • Revision R 16: Manometers for instruments for measuring blood pressure (sphygmomanometers) | 4 CD | DR |
| **TC 18/SC 2 Medical thermometers** | | |
| • Clinical electrical thermometers for continuous measurement - R 114 | R | – |
| • Clinical electrical thermometers with maximum device - R 115 | R | – |
| **TC 18/SC 5 Measuring instruments for medical laboratories** | | |
| • Absorption photometers | 1 CD | 1 CD |

activities OIML activités

# International Bureau of Legal Metrology

## Report on activities: 1995

### ADMINISTRATION

- Follow-up on the 29th CIML meeting: editing and distribution of the decisions, resolutions and minutes, and implementation of the decisions
- Revision of the Directory "Legal metrology in OIML Member States" (English version issued in January 1996)
- Report on the 1994 Development Council meeting and implementation of decisions
- Initial steps for the computerization of the administrative management and documentation center

### TECHNICAL WORK

**Technical committees and subcommittees**

- Follow-up on the activities of TCs/SCs in liaison with the secretariats; annual reports; publication of information in the OIML Bulletin; editing and translation assistance to various TCs/SCs

**Technical publications**

- Editing of, and inquiries on eight drafts, including six for CIML
- Editing, printing and distribution of 10 International Recommendations or Annexes to existing Recommendations; preparation of three additional Recommendations for print
- Electronic recording of new publications on floppy disks at the disposal of Member States

### OIML CERTIFICATE SYSTEM

- Registration of more than 100 OIML certificates; information distributed to all bodies concerned; various inquiries
- Beginning of $TAG_{cert}$ activities

### OIML LONG-TERM POLICY

- Final editing of the OIML long-term policy document under the supervision of the Presidium
- Conception and realization of the leaflet; printing and distribution to all Members and other interested bodies

### COMMUNICATIONS

- Contacts with various Members and liaison organizations
- One-week training at BIML for an employee from an OIML Member State
- OIML Bulletin: Layout carried out at BIML as of April 1995; realization of four issues (January 1995 to October 1995) and preparations for the January 1996 issue
- OIML general information brochure: final editing and layout; printing and distribution to all Members and other interested bodies, including participants in various OIML and other meetings

## OIML MEETINGS

- Preparation and organization of the Presidential Council meeting (Paris, Feb. 1995)
- Preparations for the 30th CIML Meeting (Beijing, Oct. 1995)
- Preliminary preparation of the Tenth International Conference of Legal Metrology: visit to Legal Metrology Branch, Canada, and to the place of the Conference
- TC 9/SC 2 (Teddington, December 1994 and Paris, September 1995) - TC 3 and TC 4 (Paris, June 1995) - TC 7/SC 5 (Paris, September 1995)
- Organization of the seminar "Weighing towards the year 2000" (Paris, September 1995)
- Organization of the Symposium "Metrological activities in developing countries" and the Development Council meeting (Beijing, Oct. 1995)
- Visits to Member States: Australia, Belgium, Canada, China, Indonesia, Netherlands, Slovakia, Switzerland, United Kingdom, and to Corresponding Members: Mauritius and Turkey

## OTHER MEETINGS

- Asia-Pacific Legal Metrology Forum (Sydney, December 1994 and Beijing, October 1995)
- ARSO (Mauritius, January 1995)
- WELMEC (Brussels, January 1995 and Paris, September 1995)
- European meeting on weighing in motion of road vehicles (Zurich, March 1995)
- UN/ECE/LNE/OIML workshop on metrology for countries in transition (Paris, March 1995)
- COOMET (Bratislava, April 1995)
- UNIDO workshop for Asia-Pacific countries (Beijing, April 1995)
- EUROMET (Strasbourg, May 1995)
- UN/ECE experts meeting (Geneva, May 1995)
- PTB/DAM/OIML workshop on static volume measurements (Munich, July 1995)
- ISO/DEVCO Meeting (Geneva, September 1995)
- IMEKO TC II (Gebze, October 1995)
- CGPM (Paris, October 1995)
- International Congress "Métrologie 95" (Nîmes, October 1995)

## MAINTAINING LIAISONS WITH INTERNATIONAL INSTITUTIONS

- Bureau International des Poids et Mesures (BIPM) - initial discussions on a possible merger
- International Standardization Organization (ISO), including CASCO, DEVCO and TAG 4; and International Electrotechnical Commission (IEC)
- United Nations Industrial Development Organization (UNIDO)
- International Union of Pure and Applied Chemistry (IUPAC)
- International Measurement Confederation (IMEKO)
- Comité Européen de Normalisation (CEN) and Comité Européen de Normalisation Electrotechnique (CENELEC)
- European Cooperation in Legal Metrology (WELMEC)
- Metrological Cooperation for Central and Eastern European Countries (COOMET)
- Asia-Pacific Legal Metrology Forum (APLMF) and other Asia-Pacific bodies
- North-American Metrology Cooperation (NORAMET)
- Economical Commission for Europe of the United Nations (ECE-UNO)
- and others

OIML activities MEETINGS

## PRESIDENTIAL COUNCIL

The Presidential Council met at BIML, 20–21 February 1996.

**Chairman:** G. J. Faber

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

**Other members:** S. J. Bennett, J. Birch, L. K. Issaev, B. Athané

### Main points

- The Council examined the financial situation of the Organization and its technical activity, as well as developments in certification activities, following the meeting of $TAG_{cert}$ *(see pp. 57–58)*.
- Preparations for the Tenth International Conference of Legal Metrology (Vancouver, 4–8 Nov. 1996) and the draft agenda for the Conference were discussed by the Council, which also noted the draft budget for the period 1997–2000.
- Mr Faber invited members of the Council to make known their views concerning the proposed rapprochement of the Metre Convention and OIML, before the first meeting of the joint group established for this purpose by the Presidents of the International Committees concerned (CIPM and CIML). In liaison with this important subject, cooperation between OIML and a certain number of international and regional institutions was discussed.
- President Faber decided to enlarge the composition of the Council to include certain CIML Members; the new composition will be indicated in a future issue of the Bulletin.

## CONSEIL DE PRESIDENCE

Le Conseil de la Présidence de l'OIML s'est réuni au BIML, les 20 et 21 février 1996.

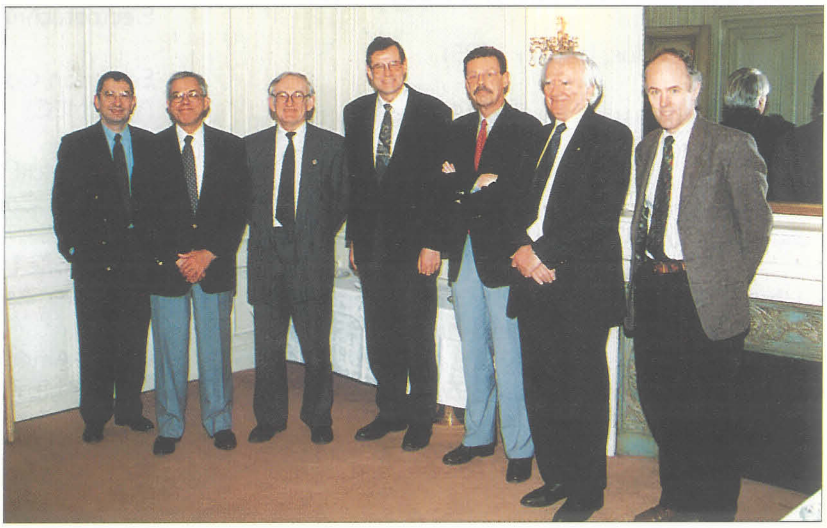
**Président:** G.J. Faber

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

**Autres membres:** S.J. Bennett, J. Birch, L.K. Issaev, B. Athané

### Points principaux

- Le Conseil a examiné la situation financière de l'Organisation, son activité technique, ainsi que les développements de l'activité de certification, à la suite de la réunion du $TAG_{cert}$ *(voir pp. 57–58)*.
- Les préparatifs pour la Dixième Conférence Internationale de Métrologie Légale (Vancouver, 4–8 novembre 1996) et le projet d'ordre du jour de la Conférence, ont été discuté par le Conseil qui, par ailleurs, a pris note du projet de budget pour la période 1997–2000.
- M. Faber a invité les membres du Conseil à faire connaître leurs vues sur le projet de rapprochement Convention du Mètre/OIML, avant la première réunion du groupe mixte établi à cet effet par les Présidents des Comités Internationaux concernés (CIPM et CIML). En liaison avec cet important sujet, la coopération entre l'OIML et un certain nombre d'institutions internationales et régionales a été discutée.



The Members of the Presidential Council in Paris, February 1996.

- Enfin, le Président Faber a décidé d'élargir la composition du Conseil à certains Membres du CIML; la nouvelle composition du Conseil sera indiquée dans un prochain numéro du Bulletin.

## TAG$_{cert}$

The first meeting of the OIML Technical Advisory Group on Certification (TAG$_{cert}$) was held 19–20 February 1996 in Paris.

**Chairman:** S. E. Chappell, USA; Vice-President of CIML

**Participation:** 21 representatives from 17 member countries and BIML.

### Main points

- Main items on the agenda: discussion of the draft revision of the document *OIML Certificate System for Measuring Instruments;* criteria for the establishment of the rules for recognition agreements of certificates and test results; preliminary discussion on certification of individual instruments; developments in the field of conformity assessment by international and regional organizations in liaison with OIML.
- The session was opened by B. Athané, Director of BIML, who presented information concerning the present state of the OIML Certificate System. Consideration was made of the present state of the System, as well as future developments of OIML certification as compared with international, regional and national requirements for testing, conformity assessment and related subjects. Discussion was connected with the recent OIML round table "Confidence in type approval", which was held in association with the 30th CIML meeting in October 1995.
- The Bureau prepared and distributed a draft revision of the document *OIML Certificate System for Measuring Instruments.* Definitions of basic terms of the document were the centre of discussion; a number of definitions such as *measuring instrument, family of measuring instruments, pattern (type) of a measuring instrument, family of patterns,* and *module,* were based on those found in VIM, VLM, R 76, D 19 and other publications. It appeared that these definitions needed further consideration by members of the group.
- The procedure for registering certificates was of interest to participants. In order to increase the level of the System as well as the protection of certificates, a few measures were proposed, such as the application by BIML of stickers to registered certificates, and the improvement of the exchange of information from CIML members and issuing authorities of registered certificates.
- Criteria for the establishment of the rules for recognition agreements were discussed. Participants were informed of the current revision by TC 3/SC 1 of D 13 on guidelines for mutual recognition of test reports and certificates. In connection with this matter, a paper on the expression of uncertainty in the field of legal metrology is being developed by France.
- Information was presented on liaisons between BIML and ISO, ILAC and EAL concerning the accreditation of laboratories and the revision by ISO/CASCO of ISO/IEC Guide 25 on technical competence of testing laboratories. This draft revision was sent to OIML TC 3 and TC 4 for consideration and comments with a view to the possible application of Guide 25 in the field of legal metrology.
- With regard to the certification of modules and the acceptance of pre-tested modules as parts of certified instruments, it was noted that the initial experience gained thus far was restricted to the certification of load cells (R 60). Concerning other modules, TCs/SCs were requested to examine the relevant Recommendations, and to decide whether they could be applied directly to the certification of such modules, or whether supplements (e.g. specific test procedures) should be necessary to this end.
- Certification of individual instruments was the subject of a preliminary discussion. An approach to such a procedure will be further considered and proposed by a NMi representative on the basis of national experience in quality control of measuring instruments.

In the conclusion of the meeting, which launched a number of important actions, the chairman requested participants to present to BIML their written comments, which will serve as a basis for a second draft revision of the document on OIML certification, and for future developments of various issues related to this activity.

## TAG$_{cert}$

La première réunion du Groupe Technique Consultatif de l'OIML sur la certification (TAG$_{cert}$) s'est tenue les 19 et 20 février 1996 à Paris.

**Président:** S.E. Chappell, Etats-Unis d'Amérique, Vice-Président du CIML

**Participation:** 21 représentants de 17 pays membres et le BIML.

### Points principaux

- Points principaux de l'ordre du jour: discussion sur le projet de révision du document *Système de Certificats OIML pour les Instruments de Mesure;* critères pour l'établissement des règles d'accords de reconnaissance des certificats et résultats d'essai; discussion préliminaire sur la certification d'instruments individuels; développements dans le domaine de l'évaluation de conformité par les organisations internationales et régionales en liaison avec l'OIML.
- La séance a été ouverte par Monsieur B. Athané, Directeur du BIML, qui a donné des informations sur l'état actuel du Système de Certificats OIML. L'état actuel du Système a été pris en considération, ainsi que les développements futurs de la certification OIML en fonction des exigences internationales, régionales et nationales pour les essais, l'évaluation de conformité et les sujets connexes. La discussion était liée à la récente table ronde "Confiance sur l'approbation type" qui s'est tenue lors de la 30e réunion du CIML en octobre 1995.
- Le Bureau a préparé et distribué un projet de révision du document *Système de Certificats OIML pour les Instruments de Mesure*. Les définitions des termes de base du document ont été le centre de la discussion; un certain nombre de définitions telles que instrument de mesure, famille d'instruments de mesure, modèle (type) d'instrument de mesure, famille de modèles et module, ont été basées sur celles des VIM, VML, R 76, D 19 et autres publications. Il est apparu que ces définitions nécessitaient une étude approfondie des membres du groupe.
- La procédure d'enregistrement des certificats intéressa les participants. En vue d'accroître le niveau du Système comme la protection des certificats, quelques mesures ont été proposées, telles que l'application par le BIML d'autocollants sur les certificats enregistrés et l'amélioration de l'échange d'informations entre les membres du CIML et les autorités de délivrance des certificats enregistrés.
- Des critères pour l'établissement des règles pour les accords de reconnaissance ont été discutés. Les participants ont été informés de la révision en cours par le TC 3/SC 1 du D 13 sur les conseils de reconnaissance mutuelle des rapports d'essai et certificats. En rapport avec ce sujet, une note sur l'expression des incertitudes dans le domaine de la métrologie légale est en cours de préparation par la France.
- Une information a été communiquée sur les liaisons entre BIML et ISO, ILAC et EAL en ce qui concerne l'accréditation des laboratoires, et la révision par ISO/CASCO du Guide 25 de ISO/CEI sur la compétence technique des laboratoires d'essai. Ce projet de révision a été envoyé à OIML TC 3 et TC 4 pour examen et commentaires en vue d'une application possible du Guide 25 dans le domaine de la métrologie légale.
- En ce qui concerne la certification des modules et l'acceptation des modules "pré-essayés" comme parties d'instruments certifiés, il a été noté que l'expérience acquise dès à présent a été limitée à la certification des cellules de pesée (R 60). En ce qui concerne les autres modules, les TC/SC ont été chargés d'examiner les Recommandations concernées et de décider si celles-ci peuvent s'appliquer directement à la certification de tels modules ou si des compléments (par exemple des procédures d'essai spécifiques) sont nécessaires à cette fin.
- La certification d'instruments individuels a fait l'objet de discussions préliminaires. Une étude de ce type de procédure devra être effectuée prochainement et proposée par les experts du NMi d'après leur expérience nationale dans le contrôle de qualité des instruments de mesure.

En conclusion de cette réunion qui a initialisé un certain nombre d'actions importantes, le Président a demandé aux participants d'envoyer par écrit au BIML leurs commentaires, qui serviront pour la rédaction d'un deuxième projet de document relatif à la certification OIML et aux développements futurs des divers aspects de cette activité.

## TC 13

### Measuring instruments for acoustics and vibration

**Secretariat: Germany**

TC 13 held a meeting in Pretoria, South Africa, on 16 February 1996 in connection with meetings of IEC/TC 29 Electroacoustics and ISO/TC 43 Acoustics.

**Chairman:** Mr Klaus Brinkmann, PTB, Germany

**Participation:** 14 delegates representing 8 P-member countries; L. Nielsen, IEC/TC 29 and ISO/TC 43 Secretariat.

### Main points

- Draft revisions of Recommendations 58 *Sound level meters,* and R 88 *Integrating-averaging sound level meters,* were reconsidered at the request of the CIML based on detailed comments submitted by the UK and the USA. As the result of extensive discussions, tests for which internationally agreed test procedures do not yet exist (i.e. for digital outputs and electromagnetic susceptibility) were cancelled from the list of mandatory tests. It is recommended, however, to include these tests during pattern evaluation and to report their results for information. Several other amendments were agreed upon to avoid any potential misinterpretation. The amended drafts were unanimously approved by the delegates.
- The comments received on the first Committee Draft on octave-band and fractional octave-band filters were considered.

  TC 13/WG 3 (conv.: G. Wong, Canada) was asked to prepare a second CD on the basis of the decisions taken with a view to circulation of the 2nd CD to the members of TC 13 for comments by the end of 1996.
- A revision of R 102 *Sound calibrators,* will be undertaken on the basis of the 2nd edition of the International Standard IEC 942, which has reached the approval stage within IEC/TC 29. TC 13/WG 4 was established, and Mrs S. P., U. K., was appointed convener.
- The next meeting of TC 13 will be held on 10 October 1997 in Japan, immediately prior to the IEC/TC 29 and ISO/TC 43 meetings at the same place.

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## TC 13

## Instruments de mesure pour l'acoustique et les vibrations

### Secrétariat: Allemagne

TC 13 a tenu une réunion à Pretoria, Afrique du Sud, le 16 février 1996 en conjonction avec des réunions de CEI/TC 29 Electroacoustique et ISO/TC 43 Acoustique.

**Président:** M. Klaus Brinkmann, PTB,Allemagne

**Participation:** 14 délégués représentant 8 pays membres-P; L. Nielsen, CEI/TC 29 et secrétariat ISO/TC 43.

### Points principaux

- Des projets de révision des Recommandations 58 *Sonomètres,* R 88 *Sonomètres intégrateurs-moyenneurs,* ont été réexaminés à la demande du CIML, sur la base de commentaires du Royaume-Uni et des Etats-Unis d'Amérique. Après des discussions approfondies, les essais pour lesquels des procédures d'essai approuvées au niveau international n'existent pas encore (par exemple, pour les sorties numériques et la susceptibilité électromagnétique) ont été enlevés de la liste des essais obligatoires. Cependant, il est recommandé d'inclure ceux-ci aux essais d'évaluation de modèle et d'en donner les résultats à titre informatif. Plusieurs autres amendements ont été approuvés afin d'éviter tout risque de mauvaise interprétation. Tous les délégués présents ont approuvé les textes modifiés.
- Les commentaires reçus sur le premier projet de comité sur les filtres d'octaves et de fraction d'octave ont été examinés. TC 13/WG 3 (rapporteur: G. Wong, Canada) a été chargé de préparer un second projet de comité sur base des décisions prises, en vue de sa distribution aux membres du TC 13 pour commentaires avant la fin de 1996.
- La révision de R 102 *Calibreurs acoustiques* sera entreprise sur base de la seconde édition de la Norme Internationale CEI 942, qui a atteint le stade d'approbation au sein de CEI/TC 29. Le groupe de travail TC 13/WG 4 a été créé et sa présidence a été attribuée à Mme S.P. Dowson, Royaume-Uni.
- La prochaine réunion du TC 13 se tiendra le 10 octobre 1997 au Japon, immédiatement avant les réunions des CEI/TC 29 et ISO/TC 43 qui se tiendront au même lieu.

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certificate system
OIML
système de certificats

# REGISTERED OIML CERTIFICATES - *CERTIFICATS OIML ENREGISTRÉS*

**1995.12 - 1996.02**

This list is classified by issuing authority; updated information on these authorities may be obtained from BIML.

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

▶ **Issuing authority** / ***Autorité de délivrance***

**Physikalisch-Technische Bundesanstalt (PTB), Germany**

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

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

**R 76/1992 - DE - 93.01**
Sartorius AG
Weender Landstraße 94-108, D-37075 Göttingen, Germany
*BA BA 200, BA BB 200, ...*

OIML Recommendation applicable within the System / Year of publication

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

Year of issue
*Année de délivrance*

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

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

Manufacturer / *Fabricant*
Certified pattern(s) / *Modèle(s) certifié(s)*

## INSTRUMENT CATEGORY
*CATÉGORIE D'INSTRUMENT*

### Load cells
*Cellules de pesée*

### R 60 (1991), Annex A (1993)

▶ **Issuing authority** / ***Autorité de délivrance***

**National Weights and Measures Laboratory (NWML), United Kingdom**

**R60/1991-GB-95.26**
Weigh-Tronix Inc., Fairmont, MN 56031-1000, USA
*Load Cell Model No DCX (Class C)*

**R60/1991-GB-95.27**
Veccer Ltd., 5 Trafford Road, Reading, Berks, RG1 8JP, Great Britain
*Load Cell Model No Veccer VC 5593 (Class C)*

**R60/1991-GB-95.28**
KPZ-Waagen, Neuer Dreikatendeich 28, D-21129, Hamburg 95, Germany
*Load Cell Model No KPZ502 (Class C)*

▶ **Issuing authority** / ***Autorité de délivrance***

**Netherlands Measurement Institute (NMi) IJkwezen B.V., The Netherlands**

**R60/1991-NL-95.09 Rev. 1**
Tedea Huntleigh Europe Ltd., 37 Portmanmoor Road, Cardiff, CF2 2HB, United Kingdom
*220/230 (Classes C and D)*

**R60/1991-NL-95.15**
HBM Inc., 19 Bartlett Street, Marlboro, MA 01752, USA
*SP4 (Class C)*

**R60/1991-NL-95.16**
SEG Instrument AB, Gjuterivägen 21, S-161 30 Bromma, Sweden
*KPS4-... (Classes C and D)*

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**INSTRUMENT CATEGORY**
*CATÉGORIE D'INSTRUMENT*

**Nonautomatic weighing instruments**
*Instruments de pesage à fonctionnement non automatique*

**R 76-1 (1992), R 76-2 (1993)**

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**Issuing authority / *Autorité de délivrance***

**Physikalisch-Technische Bundesanstalt (PTB), Germany**

**R76/1992-DE-95.03**
Sartorius A.G., Weender Landstraße 94-108, D-37075 Göttingen, Germany
*BB BD 523, HA BD 523 (Classes II and III) and DK BD 323 (Class III)*

**Issuing authority / *Autorité de délivrance***

**Netherlands Measurement Institute (NMi) IJkwezen B.V., The Netherlands**

**R76/1992-NL-95.23**
Avery Berkel, Foundry Lane, Smethwick, B66 2LP Great Britain
*DX342 (Class III)*

**R76/1992-NL-95.24**
Mettler-Toledo A.G., Im Langacher, 8606 Greifensee, Switzerland
*SB (Classes II and III)*

**R76/1992-NL-95.25**
Teraoka Seiko Co., Ltd., 12-13 Kugahara, 5-Chome, Otha-ku, Tokyo 146, Japan
*DC-150 (Class I)*

**R76/1992-NL-95.27**
Tokyo Electric Co., Ltd., 6-78, Minami-cho, Mishima-shi, Shizuoka-ken, 411, Japan
*SL9000 (Class III)*

**R76/1992-NL-95.28**
A&D Instruments Ltd., Abingdon Science Park, Abingdon, Oxford, OX14 3YS Great Britain
*HF-EC (Class II)*

**R76/1992-NL-95.29**
Teraoka Seiko Co., Ltd., 12-13 Kugahara, 5-Chome, Otha-ku, Tokyo 146, Japan
*FX-3600 (Class III)*

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**INSTRUMENT CATEGORY**
*CATÉGORIE D'INSTRUMENT*

**Clinical electrical thermometers**
*Thermomètres électriques médicaux*

**R 115 (1995)**

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**Issuing authority / *Autorité de délivrance***

**Physikalisch-Technische Bundesanstalt (PTB), Germany**

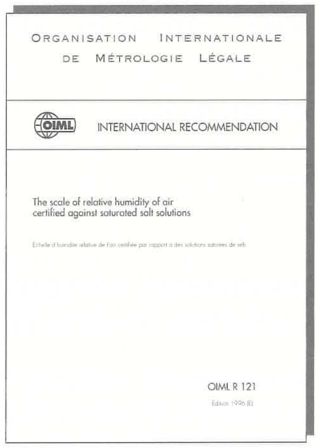
**R115/1995-DE-95.01**
Integrated Display Technology Ltd., 41, Man Yue Street, Hongkong
*WBT-338 H (Class I)*

## OIML TECHNICAL ADVISORY GROUP ON CERTIFICATION ($TAG_{cert}$)

The Technical Advisory Group on Certification ($TAG_{cert}$) was established by the resolution of the 29th CIML meeting in 1994 with a view to studying and preparing proposals on further development of the OIML Certificate System. Initial activities of the group in 1995 were its composition and three inquiries concerning the work topics for $TAG_{cert}$, activities of issuing authorities for OIML certificates, and opinions of manufacturers of instruments having received OIML certificates (see also BIML Bulletin No. 4, October 1995). At present, there are 20 countries registered in $TAG_{cert}$ as members.* The 30th CIML meeting, held in October 1995, approved the main fields of $TAG_{cert}$ activities and recommended that its first meeting be organized *(see pp. 57–58)*.

*(*) Australia, China, Denmark, France, Germany, Hungary, Indonesia, Japan, Rep. of Korea, Netherlands, Norway, Poland, Romania, Russia, Slovakia, Slovenia, Switzerland, United Kingdom, United States of America, Yugoslavia.*

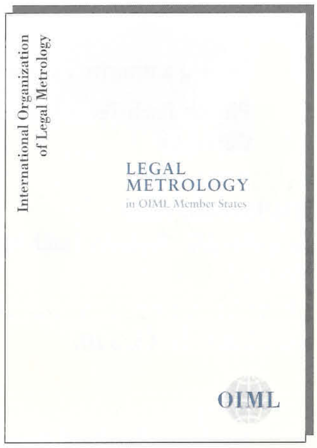
# NEW PUBLICATIONS
# *NOUVELLES PUBLICATIONS*




R 119 Pipe provers for testing measuring systems for liquids other than water
*Tubes étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau*

R 121 The scale of relative humidity of air certified against saturated salt solutions
*Échelle d'humidité relative de l'air certifiée par rapport à des solutions saturées de sels*

R 122 Equipment for speech audiometry
*Appareils pour l'audiométrie vocale*




Legal metrology in OIML Member States (1996)
*Métrologie légale dans les États Membres de l'OIML (1996)*

*Available in French and English (see OIML Bulletin supplement for price-list). To order a publication, please contact OIML headquarters:*
*Bureau International de Métrologie Légale 11, rue Turgot - 75009 Paris - France Fax: 33 1 42 82 17 27*

## Committee drafts received by BIML

December 1995–February 1996

| Stage of development | Title | TC/SC | Secretariat |
|---|---|---|---|
| 1 CD | Vocabulary of legal metrology | TC 1 | Poland |
| 3 CD | R 50: Test procedures and pattern evaluation report | TC 9/SC 2 | U.K. |
| 1 CD | Method of carrying out pH-measurement. Certification methods of solutions for verification of pH-meters | TC 17/SC 3 | Germany |

REGIONAL COOPERATION IN METROLOGY

# WELMEC: the first five years

**S. BENNETT,** Chief Executive, National Weights and Measures Laboratory (NWML), United Kingdom and WELMEC Chairman

*Abstract*

*The formal European co-operation in the field of legal metrology (WELMEC) was created in 1990. With the objectives of improving communication, increasing harmonisation, and removing barriers to trade in measuring instruments, WELMEC has maintained a programme of collaboration aimed at the identification of areas of agreement as well as the discussion and resolution of differences of view. Eighteen countries are full members of WELMEC, including all 15 of the European Union (EU) members. In addition, five countries in central Europe have joined WELMEC as Associate Members as they prepare for eventual full membership of the EU.*

*WELMEC has collaborated closely with the European Commission in the interpretation and application of the non-automatic weighing instruments Directive and will play a similar role with respect to the forth-coming Directive on measuring instruments. It has also published nine documents and the WELMEC members have entered into a type approval agreement based on compliance with OIML Recommendations.*

## Is there a need for regional co-operation in legal metrology?

Co-operation is the basis of progress in many international spheres of activity. In trade, in politics, in war – nations co-operate with various degrees of success and, it must be said, with a mixture of motives. Development through co-operation has long been a theme in political and economic discussions between countries and in legal metrology the alignment and harmonisation of different national traditions and practices is leading to increased co-operation at the regional level. Any such co-operation is bound to be on a modest scale but may nevertheless bring substantial rewards if entered into with clear commitment and well-defined objectives.

Until five years ago, international co-operation in legal metrology was mostly limited to participation in OIML, which has been conspicuously successful in obtaining agreement on the metrological performance requirements for measuring instruments. More than a hundred Recommendations have been published, covering a wide range of instruments ranging from weights to electro-encephalographs and from volumetric flasks to sound calibrators.

These publications are forming the basis of metrology legislation in an increasing number of countries around the world. Developed and developing countries alike are discovering the benefits that accrue from the use of specifications that have been thoroughly discussed and painstakingly prepared in an international forum. Effective regional co-operation, however, involves more than the recognition of OIML Recommendations as a common basis for regulation. There is more to it than agreeing to use the same script!

Co-operation at the regional level has developed since 1990, with the establishment of several initiatives. In 1990, WELMEC was created to facilitate co-operation in legal metrology in western Europe and COOMET was set up as a general metrology collaboration between the countries of central and Eastern Europe. More recently, a co-operation is developing in North America, and the Asia Pacific Legal Metrology Forum represents a wider co-operation involving the countries of the Pacific rim.

## How does WELMEC operate?

WELMEC was founded in June 1990 when a Memorandum of Understanding was signed at Bern, Switzerland. The MoU now bears the signatures of representatives of 18 western European countries in the European Union and EFTA. It must be stressed, however, that WELMEC is a free co-operation which in no way binds the signatories. There are no voting rules and no prior commitment to accept majority decisions.

The WELMEC Committee consists of delegates from those national bodies which have signed the Memorandum of Understanding, a number of Associate Members, and observers from other organisations with particular interest in legal metrology in Europe. In addition, WELMEC recognises as Corresponding Organisations European trade associations representing manufacturers of measuring instruments as well as other regional metrology organisations. To date, COOMET has been recognised as a Corresponding Organisation, as have European trade associations for manufacturers of weighing instruments (CECIP) and petrol dispensers (CECOD). WELMEC also receives regular correspondence from metrology institutes in countries outside western Europe with requests for information about the co-operation.

Closer co-operation with countries in central and eastern Europe is developing and five central European countries (Hungary, Poland, Romania, Slovakia and the Czech Republic) have recently become Associate Members of WELMEC. These so-called "countries in transition" will thus be able to participate more fully in WELMEC's activities in preparation for eventual full membership as members of the European Union.

The Memorandum of Understanding establishing WELMEC contains clear objectives for the co-operation:

(i) to develop and maintain mutual confidence between legal metrology services in Europe;

(ii) to achieve and maintain the equivalence and harmonisation of legal metrology activities taking into account the relevant guidelines;

(iii) to identify any special features of legal metrology which need to be reflected in the European metrology, certification and testing framework;

(iv) to organise the exchange of information for legal metrology applied at national and local level;

(v) to identify, and promote the removal of, technical or administrative barriers to trade in the field of measuring instruments;

(vi) to promote consistency of interpretation and application of normative documents and propose actions to facilitate implementation;

(vii) to identify specific technical problems which might form the subject of collaborative projects;

(viii) to maintain working links with all relevant bodies and promote the infrastructure relating to harmonisation of legal metrology;

(ix) to debate trends and establish criteria for the scope of legal metrology and maintain channels for a continuous flow of knowledge.

In addition to a small Chairman's Group there are eight WELMEC Working Groups:

***Working Group 2*** - *Non-automatic weighing instruments Directive*

***Working Group 3*** - *Type approvals data base*

***Working Group 4*** - *Quality Assurance standards in legal metrology*

***Working Group 5*** - *Legal metrology enforcement in Europe*

***Working Group 6*** - *Regulation of packaged goods*

***Working Group 7*** - *Peripherals and computers*

***Working Group 8*** - *Measuring instruments Directive*

***Working Group 9*** - *WELMEC type approval agreement*

Working Group 2 has been extremely active, following the implementation of the non-automatic weighing instruments Directive (90/384/EEC). This is the first New Approach Directive in the field of legal metrology. It is designed to ensure free movement for weighing instruments which comply with the essential requirements. In line with the New Approach, manufacturers may choose to demonstrate compliance with the relevant European Standard (EN45501) or to address the essential requirements directly. There is also a choice of conformity assessment modules, which replace the existing arrangements in the Member States. Working Group 2 has met frequently, in close co-operation with the European Commission, to resolve specific questions of interpretation and application arising from the Directive. The deliberations of Working Group 2 led to the publication of two guidance documents on the interpretation and application of the Directive and the European Standard. The "application" document includes a model format for a Certificate of EC type approval, summarises areas where agreement has been reached on the way in which the Directive should be applied and lists information specific to individual countries. The document on interpretation of the Directive reproduces text prepared by the European Commission following discussions in WELMEC Working Group 2.

The quick, efficient exchange of information about weighing instruments which have received European type approval under measuring instrument Directives is an essential requirement of the new arrangements. Working Group 3 has established both an on-line database and a more detailed register of approvals published on CD-ROM. Both the on-line service and a prototype CD-ROM publication, supported by funding from the European Commission and the EFTA Secretariat, are now being provided under contract by a consortium in the United Kingdom.

Working Group 4 has published a "Guide for notified bodies performing conformity assessments of measuring instruments", which is intended as an aid for those who are applying the European standards EN45011 and EN45001 to bodies responsible for conformity assessment procedures in the field of legal metrology. The widespread adoption of the principles in this guide will contribute to the objectives of WELMEC by ensuring common application of the standards to bodies responsible for type approval and verification in order to achieve a level playing field in the certification of measuring instruments.

The work of Working Group 5 involves those responsible for the enforcement of legal metrology and the Working Group secretariat has prepared a directory of European legal metrology, which has just been published. This review, a successor to the 1989 LACOTS report on European metrology (updated with recent data and extended to include the EFTA countries), has involved the collection of information from all 18 WELMEC full member countries about the scope of legal controls and their administration, as well as the extent of enforcement in each country.

The WELMEC Committee during its meeting in Paris, 11–12 September 1995.

Working Group 6 (Prepackages) has met two or three times to discuss issues arising from the application of statistical sampling methods to pre-packaged goods.

In addition to the discussions in Working Group 2 of the testing requirements for indicators and point of sale devices connected to non-automatic weighing instruments, Working Group 7 has been preparing a more general document: "Guidelines for Interfaces and Peripheral Equipment". This draft has been agreed by the members of the Working Group, and has been seen by interested trade associations, prior to the preparation of a final version for publication.

The Directive 90/384/EEC only concerns non-automatic weighing instruments, and a further Directive with a much wider scope is in preparation. It is intended that this document will deal with all measuring instruments, creating a single framework for the legal control of measuring instruments and establishing a single market in Western Europe for such products. With the acceleration of work on this Directive, WELMEC Working Group 8 has been discussing the implications of the Commission's draft and has made its own recommendations on specific issues which arise. When the Directive is adopted, this Working Group will continue to provide advice and input to the European Commission on questions of interpretation as well as attempting to resolve issues arising from its application and implementation.

A further Working Group (WG9) has recently been established to monitor the operation of the WELMEC Type Approval Agreement. This Agreement has been drawn up in recognition of the growing assumption under European law that if a product has been tested and placed on the market in one Member State it should enjoy free movement throughout the European Economic Area. At the same time, OIML has published Recommendations covering a wide range of measuring instruments. These publications, many of which now include test procedures and model test reports, already form the basis of legislation in many countries.

Against this background, the WELMEC Committee discussed during 1993 how technical and administrative barriers to trade in measuring instruments might be removed. While a general Directive on measuring instruments may provide for European certification of instruments in due course, what was needed was a degree of harmonisation in the short term on the basis of mutual confidence and common technical specifications.

Following extensive discussion, the WELMEC Committee considered that OIML Recommendations could form the basis of a recognition agreement for type approvals in Europe. This agreement (which has been signed by all the WELMEC Members) consists of a clear declaration by the signatories of their firm intention to accept conformity with an OIML Recommendation as the basis of a national type approval with little or no further examination where the instrument has already been granted approval in another signatory country. It is hoped that this agreement will open up an effective single market in the period leading up to the adoption of a measuring instruments Directive.

The agreement originally covered automatic weighing instruments, but has now been extended to include petrol dispensers and mass flow meters.

## What about publications?

As mentioned above, WELMEC has published a number of publications containing information about WELMEC and agreed guidance on matters of significance in European legal metrology. Nine documents have been published to date:

WELMEC 1
*An Introduction to WELMEC*

WELMEC 2
*Common application of Directive 90/384/EEC and EN45501*

WELMEC 2.1
*Guide for Testing Indicators (Non-automatic Weighing Instruments)*

WELMEC 2.2
*Guide for Testing Point of Sale Devices (Non-automatic Weighing Instruments)*

WELMEC 2.3
*Guide for Examining Software (Non-automatic Weighing Instruments)*

WELMEC 3
*Guide for notified bodies performing conformity assessments of measuring instruments*

WELMEC 4
*The WELMEC Type Approval Agreement*

WELMEC 5
*Directive 90/384/EEC: Explanation and Interpretation*

WELMEC 6
*European Legal Metrology Directory*

Some of these are currently being revised and further publications are in preparation, including a supplement to WELMEC 6 covering the Associate Member countries in central Europe.

## What lessons have been learnt?

While WELMEC may not be a perfect model for regional co-operation in legal metrology elsewhere in the world, I am sure there are lessons to be learnt which may be of value to others. I should like to point to seven lessons which we have learnt in WELMEC and which I believe would be important principles for any effective co-operation of this type.

1. In the first place, *full participation* has greatly enhanced the standing and the effectiveness of WELMEC. This meant ensuring universal acceptance of the MoU and keeping all members fully informed about progress. While some member countries play a much more active part than others, all members are regularly consulted and are encouraged to take part in WELMEC activities in some way or other.

2. It is essential to *establish clear objectives at the outset*. In the case of WELMEC these are set out in the Memorandum of Understanding and they reflect the realities of the European Union and the associated Single Market.

3. WELMEC has maintained progress by *letting the members set the agenda*. This ensures that issues and concerns are addressed as they arise without following any long-term agenda set in advance.

4. Progress is achieved by *consensus, not compulsion*. The absence of binding decisions on the basis of majority voting rules was initially seen as a potential weakness but the outcome has been rather different. Full participation is much easier to achieve where there is no prior binding commitment and decisions reached by consensus have been universally accepted and widely implemented.

5. We have found in WELMEC that initial progress is most readily achieved by concentrating on *identifying areas of agreement*. Beginning with the Memorandum of Understanding we have sought to identify and record those matters, whether technical or procedural, on which we can agree absolutely and to use such agreement as

the basis for discussion of more difficult issues where there may be strongly held differences of opinion to resolve.

6. Linked to the above is the importance of *achieving some early successes.* While there may be major issues which will take months, or even years, of discussion to resolve, the publication of a guidance document or the signature of an agreement will raise the wider perception of any collaboration and generate momentum for further achievements. WELMEC's successes have included the publication of a number of authoritative documents, the creation of a European type approvals database and the signature of the Type Approval Agreement. Without these, and no matter how high the quality of debate, the reputation of the co-operation would not be what it is and it must be doubtful whether its members would still be spending much time on it.

7. Finally, it would be difficult to underestimate the importance of *good communications with other regional and international bodies.* A number of observers attend WELMEC Committee meetings, including representatives of OIML, the European Commission and EAL (European Accreditation of Laboratories) and WELMEC maintains good contacts with other bodies and associations who are recognised as Corresponding Organisations. Decisions and proposals that have general acceptance and have been the subject of wide consultation are less likely to face subsequent obstacles.

## What is WELMEC doing now?

WELMEC continues to be preoccupied with the consequences of the existing Directive on non-automatic weighing instruments and with discussion of the prospects for a general measuring instruments Directive. Close co-operation and frequent communication between the WELMEC members will continue to be of the utmost importance to ensure harmonised implementation and adequate mutual confidence in certification procedures.

The implementation of the European Directive on measuring instruments may well be five years away. Meanwhile, the type approval Agreement will reduce obstacles to the free movement of measuring instruments and go some way towards eliminating the repeated testing and evaluation of instruments. WELMEC is monitoring progress with this agreement and provides channels of communication for resolving difficulties as they arise. It is also facilitating enforcement of legal metrology Directives through closer contacts between enforcement agencies in the various member countries.

All of this means a very full programme in the years to come, for which WELMEC has recently recognised the changing face of Europe by dropping references to "Western Europe" in its title and describing itself instead as "European co-operation in legal metrology". While increased size will undoubtedly bring its own problems, it will also provide further opportunities for the development of legal metrology through regional co-operation. Resources for this will be provided through the establishment of a secretariat funded by the WELMEC members from 1 January 1996. ■

*Further information about WELMEC and its activities is available from the secretary, Peter Edwards at the National Weights and Measures Laboratory, Stanton Avenue, Teddington TW11 0JZ, United Kingdom (Fax: +44 181 943 7270).*

meetings
# OIML
réunions

## May 1996

**20–24** TC 9 — BRAUNSCHWEIG
Instruments for measuring mass and density — *Subject to confirmation*
TC 9/SC 2
Automatic weighing instruments

## June 1996

**10–12** TC 8/SC 7 — BRUSSELS
Gas metering

## October 1996

**2–4** OIML workshop: Practical test procedures for classes $E_1$ to $M_3$ weights — BORÅS, SWEDEN

*To be fixed* TC 17 — ST. PETERSBURG
Instruments for physico-chemical measurements
TC 17/SC 2
Saccharimetry
TC 17/SC 4
Conductometry
TC 17/SC 5
Viscometry
TC 17/SC 6
Gas analysis

*To be fixed* TC 7/SC 5 — TO BE FIXED
Dimensional measuring instruments

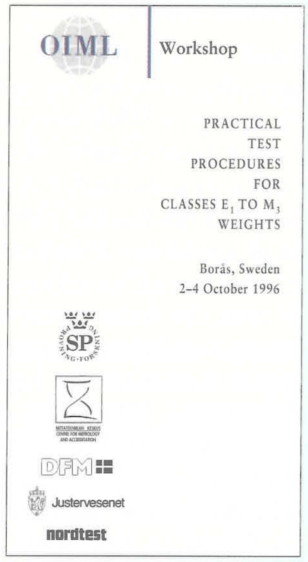
## November 1996

**4–8** Tenth International Conference of Legal Metrology — VANCOUVER, CANADA
31st CIML meeting
Development Council meeting

## October 1997

**10** TC 13 — JAPAN
Measuring instruments for acoustics and vibration

# info


OIML | Workshop

PRACTICAL
TEST
PROCEDURES
FOR
CLASSES $E_1$ TO $M_3$
WEIGHTS

Borås, Sweden
2–4 October 1996

SP
DFM
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nordtest

### Scope

To present the draft test procedures for the application of OIML International Recommendation R 111 *Weights of classes $E_1$, $E_2$, $F_1$, $F_2$, $M_1$, $M_2$, $M_3$*, which will have an important impact on the production of weights and balances, and on the various procedures for verification, calibration, and approval of weights. Special attention will be given to the "new" requirements for density, magnetic susceptibility, surface roughness, and construction.

### Participation

Verification officers; scientists; technicians and engineers from verification centers, standardization bodies; manufacturers of weights and weighing instruments

**Language:** English

**Workshop fee:** 2 500 Swedish Kronur

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*classified by subject and number*

International Recommendations
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Other publications

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

## 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*

**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** (1996) 400 FRF
Legal metrology in OIML Member States
*Métrologie légale dans les Etats Membres de l'OIML*

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

**P 17** (1995) 300 FRF
Guide to the expression of uncertainty in measurement
*Guide pour l'expression de l'incertitude de mesure*

## Measurement standards and verification equipment
## *Étalons et équipement de vérification*

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

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

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

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

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

**P 4** (1986–*1981*) 100 FRF
Verification equipment for National Metrology Services
*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

## 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** (being printed - *en cours de publication*)
Automatic catchweighing instruments
*Instruments trieurs-étiqueteurs à fonctionnement automatique*

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

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

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

**R 61** (being printed - *en cours de publication*)
Automatic gravimetric filling instruments
*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*

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

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

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

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

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

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

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

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

**P 5** (1992) 100 FRF
Mobile equipment for the verification of road 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*

## Length and speed
## *Longueurs et vitesses*

**R 21** (1975–*1973*) 60 FRF
Taximeters
*Taximètres*

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

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

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

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

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

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

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

## Liquid measurement
## *Mesurage des liquides*

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

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

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

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

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

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

**R 49** (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 63** (1994) 50 FRF
Petroleum measurement tables
*Tables de mesure du pétrole*

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

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

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

**R 81** (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*

Annex (1995) 80 FRF
Test report format
*Format du rapport d'essai*

**R 117** (1995) 400 FRF
Measuring systems for liquids other than water
*Ensembles de mesurage de liquides autres que l'eau*

**R 118** (1995) 100 FRF
Testing procedures and test report format for pattern evaluation of fuel dispensers for motor vehicles
*Procédures d'essai et format du rapport d'essai des modèles de distributeurs de carburant pour véhicules à moteur*

**R 119** (1996) 80 FRF
Pipe provers for testing measuring systems for liquids other than water
*Tubes étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau*

**R 120** (being printed - *en cours de publication*)
Standard capacity measures for testing measuring systems for liquids other than water
*Mesures de capacité étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau*

**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*

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

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

## Gas measurement
## *Mesurage des gaz(*)*

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

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

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

## Pressure
## *Pressions(**)*

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

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(*) See also "Liquid measurement" D 25 - *Voir aussi "Mesurage des liquides" D 25.*

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

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

**R 97** (1990) 60 FRF
Barometers
*Baromètres*

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

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

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

## Temperature
## *Températures(*)*

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

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

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

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

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

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

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

## Electricity
## *Électricité*

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

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

## Acoustics and vibration
## *Accoustique et vibrations(*)*

**R 58** (1984) 50 FRF
Sound level meters
*Sonomètres*

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

**R 102** (1992) 50 FRF
Sound calibrators
*Calibreurs acoustiques*

Annex (1995) 80 FRF
Test methods for pattern evaluation and test report format
*Méthodes d'essai de modèle et format du rapport d'essai*

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

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

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

## Environment
## *Environnement*

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

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

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

**R 100** (1991) 80 FRF

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

**R 112** (1994) 80 FRF

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

**R 113** (1994) 80 FRF

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

**R 116** (1995) 80 FRF

Inductively coupled plasma atomic emission spectrometers for measurement of metal pollutants in water
*Spectromètres à émission atomique de plasma couplé inductivement pour le mesurage des polluants métalliques dans l'eau*

**R 123** (being printed - *en cours de publication*)

Portable and transportable X-ray fluorescence spectrometers for field measurement of hazardous elemental pollutants
*Spectromètres à fluorescence de rayons X portatifs et déplaçables pour la mesure sur le terrain d'éléments polluants dangereux*

**D 22** (1991) 80 FRF

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

## Physico-chemical measurements
## *Mesures physico-chimiques*

**R 14** (1995) 60 FRF

Polarimetric saccharimeters
*Saccharimètres polarimétriques*

**R 54** (in revision - *en cours de révision*)

pH scale for aqueous solutions
*Echelle de pH des solutions aqueuses*

**R 56** (1981) 50 FRF

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

**R 59** (1984) 80 FRF

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

**R 68** (1985) 50 FRF

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

**R 69** (1985) 50 FRF

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

**R 70** (1985) 50 FRF

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

**R 73** (1985) 50 FRF

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

**R 92** (1989) 60 FRF

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

**R 108** (1993) 60 FRF

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

**R 121** (1996) 60 FRF

The scale of relative humidity of air certified against satured salt solutions
*Échelle d'humidité relative de l'air certifiée par rapport à des solutions saturées de sels*

**D 17** (1987) 50 FRF

Hierarchy scheme for instruments measuring the viscosity of liquids
*Schéma de hiérarchie des instruments de mesure de la viscosité des liquides*

## Medical instruments
## *Instruments médicaux*

**R 7** (1979-*1978*) 60 FRF

Clinical thermometers, mercury-in-glass with maximum device
*Thermomètres médicaux à mercure, en verre, avec dispositif à maximum*

**R 16** (1973-*1970*) 50 FRF

Manometers for instruments for measuring blood pressure (sphygmomanometers)
*Manomètres des instruments de mesure de la tension artérielle (sphygmomanomètres)*

**R 26** (1978-*1973*) 50 FRF

Medical syringes
*Seringues médicales*

**R 78** (1989) 50 FRF

Westergren tubes for measurement of erythrocyte sedimentation rate
*Pipettes Westergren pour la mesure de la vitesse de sédimentation des hématies*

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

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

**R 93** (1990) 60 FRF
Focimeters
*Frontofocomètres*

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

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

**R 122** (1996) 60 FRF
Equipment for speech audiometry
*Appareils pour l'audiométrie vocale*

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

## Testing of materials
## *Essais des matériaux*

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

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

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

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

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

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

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

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

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

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

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

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

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

**P 11** (1983) 100 FRF
Factors influencing hardness measurement

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

**P 13** (1989) 100 FRF
Hardness standard equipment

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

## Prepackaging
## *Préemballages*

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

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

INTERNATIONAL RECOMMENDATIONS
*RECOMMANDATIONS INTERNATIONALES*

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

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

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

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

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

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

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

**R 14** (1995) 60 FRF
Polarimetric saccharimeters
*Saccharimètres polarimétriques*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**R 51** (being printed - *en cours de publication*)
Automatic catchweighing instruments
*Instruments trieurs-étiqueteurs à fonctionnement automatique*

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

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

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

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

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

**R 58** (1984) 50 FRF
Sound level meters
*Sonomètres*

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

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

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

**R 61** (being printed - *en cours de publication*)
Automatic gravimetric filling instruments
*Doseuses pondérales à fonctionnement automatique*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**R 93** (1990) 60 FRF
Focimeters
*Frontofocomètres*

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

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

**R 97** (1990) 60 FRF
Barometers
*Baromètres*

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

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

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

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

**R 102** (1992) 50 FRF
Sound calibrators
*Calibreurs acoustiques*

Annex (1995) 80 FRF
Test methods for pattern evaluation and test report format
*Méthodes d'essai de modèle et format du rapport d'essai*

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

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

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

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

Annex (1995) 80 FRF
Test report format
*Format du rapport d'essai*

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

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

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

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

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

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

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

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

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

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

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

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

**R 116** (1995) 80 FRF
Inductively coupled plasma atomic emission spectrometers for measurement of metal pollutants in water
*Spectromètres à émission atomique de plasma couplé inductivement pour le mesurage des polluants métalliques dans l'eau*

**R 117** (1995) 400 FRF
Measuring systems for liquids other than water
*Ensembles de mesurage de liquides autres que l'eau*

**R 118** (1995) 100 FRF
Testing procedures and test report format for pattern evaluation of fuel dispensers for motor vehicles
*Procédures d'essai et format du rapport d'essai des modèles de distributeurs de carburant pour véhicules à moteur*

**R 119** (1996) 80 FRF
Pipe provers for testing measuring systems for liquids other than water
*Tubes étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau*

**R 120** (being printed - *en cours de publication*)
Standard capacity measures for testing measuring systems for liquids other than water
*Mesures de capacité étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau*

**R 121** (1996) 60 FRF
The scale of relative humidity of air certified against saturated salt solutions
*Échelle d'humidité relative de l'air certifiée par rapport à des solutions saturées de sels*

**R 122** (1996) 60 FRF
Equipment for speech audiometry
*Appareils pour l'audiométrie vocale*

**R 123** (being printed - *en cours de publication*)
Portable and transportable X-ray fluorescence spectrometers for field measurement of hazardous elemental pollutants
*Spectromètres à fluorescence de rayons X portatifs et déplaçables pour la mesure sur le terrain d'éléments polluants dangereux*

INTERNATIONAL DOCUMENTS
*DOCUMENTS INTERNATIONAUX*

**D 1** (1975) 50 FRF
Law on metrology
*Loi de métrologie*

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

**D 3** (1979) 60 FRF
Legal qualification of measuring instruments
*Qualification légale des instruments de mesurage*

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

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

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

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

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

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

**D 10** (1984) 50 FRF
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