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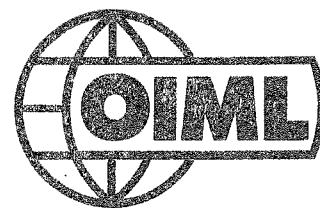
BULLETIN

DE

L'ORGANISATION

INTERNATIONALE

DE MÉTROLOGIE LÉGALE



30 ANS

Organe de Liaison entre les Etats membres



BUREAU INTERNATIONAL DE METROLOGIE LEGALE
11, Rue Turgot — 75009 PARIS — France

BULLETIN

de

l'ORGANISATION INTERNATIONALE de MÉTROLOGIE LÉGALE

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L'OIML a 30 ANS

La publication du Numéro 100 du Bulletin de l'OIML coïncide avec le 30ème anniversaire de la signature, faite à Paris le 12 octobre 1955, de la Convention instituant l'Organisation Internationale de Métrologie Légale.

Cependant, l'idée de créer un organisme international s'occupant de métrologie pratique ou légale est beaucoup plus ancienne, puisqu'une proposition officielle avait déjà été faite en 1913, précédée sans doute de nombreuses discussions.

Alors que certains fondateurs de l'OIML nous ont déjà quittés, le BIML a pensé qu'il convenait de conserver une trace écrite des événements des décennies qui nous précèdent.

La longue histoire de l'OIML reste cependant à écrire et nous rappelons dans ce numéro anniversaire simplement les faits marquants, par une chronologie succincte :

1875 Convention du Mètre et création du Bureau International des Poids et Mesures.

1913 La Cinquième Conférence Générale des Poids et Mesures adopte la résolution suivante :

« La Conférence générale donne au Comité international le mandat d'examiner la proposition du Gouvernement italien, en vue de provoquer, entre les Etats intéressés, une entente sur le choix des instruments à soumettre à la vérification officielle et sur les prescriptions à édicter relativement à cette vérification, dans le but de permettre les échanges ultérieurs de ces instruments entre les divers pays ».

La Délégation roumaine propose dans cet esprit « une réunion des directeurs des Poids et Mesures des différents pays, qui pourraient préparer une entente sur ces questions ».

1933 Huitième Conférence Générale des Poids et Mesures :
Résolution 15 : Etude de la création d'un Comité consultatif de Métrologie pratique :

« La Conférence ayant été saisie d'une proposition des Délégués de l'U.R.S.S., tendant à constituer un Comité consultatif de Métrologie appliquée auprès du Comité international des Poids et Mesures, charge le Comité International de l'étude de cette question ».

1937 Exposition Universelle à Paris ; la France célèbre le centenaire de la création de son Service des Poids et Mesures. Répondant aux vœux de la Conférence Générale des Poids et Mesures, le Gouvernement français a décidé de réunir une Première Conférence Internationale de Métrologie pratique. Les motions proposées par les délégations française, polonaise, roumaine et yougoslave et adoptées à la Conférence forment la base de la future OIML.

Un Comité provisoire de métrologie légale est créé sous la Présidence de M. RAUSZER et M. COSTAMAGNA est nommé Secrétaire.

1938 Le Comité International provisoire de Métrologie Légale devait se réunir en à 1938 et la Neuvième Conférence Générale des Poids et Mesures était prévue
1945 pour 1939. Les événements internationaux qui durèrent jusqu'en 1945 empêchèrent toute réunion et tout travail.

1950 Réunions à Paris et à Bruxelles du Comité International provisoire de Métrologie et Légale, sous la Présidence de M. JACOB. Le texte de la Convention instituant
1952 l'OIML commence à prendre forme.

La future collaboration avec l'ISO, la CEI, l'UNESCO... et bien sûr le BIPM est évoquée. Le Secrétariat devenu pratiquement permanent est toujours assuré par M. COSTAMAGNA. Parmi les autres acteurs, on relève les noms de MM. BEFAHY, KÖNIG, POPPY, STULLA-GÖTZ, VIAUD, VIEWEG...

- 1954 A l'occasion de la Dixième Conférence Générale des Poids et Mesures, réunion d'information du Comité International provisoire de Métrologie Légale ; la création de l'OIML en tant qu'organisation intergouvernementale indépendante à la fois du BIPM et de l'ONU a été virtuellement acceptée par de nombreux pays.

12 octobre 1955 : 22 Etats ont signé la Convention

- 1956 La Première Conférence Internationale de Métrologie Légale a lieu à Paris. 23 Etats Membres, 3 Etats Correspondants, 4 Etats Observateurs, 6 Institutions Internationales, y sont représentés. En plus des personnalités déjà mentionnées, on relève deux noms de Membres actuels du CIML : MM. LIERS et MÜHE. M. JACOB est élu Président du CIML.
- 1959 Le Bureau International de Métrologie Légale, précédemment hébergé par l'Administration française, s'installe dans ses propres locaux, 9, avenue Franco-Russe à Paris 7ème. Le personnel se compose de M. COSTAMAGNA, Directeur, M. JASNORZEWSKI, adjoint, Mme HOUDOUIN, Secrétaire, auquel va se joindre M. CAURO, documentaliste.
- 1960 Le CIML tient sa 3ème réunion. Le Bulletin de l'OIML est créé ; le programme de travail comprend quelques 70 sujets parmi lesquels on relève :
- les appareils de pesage électroniques,
 - les indications de masse ou volume sur les produits conditionnés,
 - les appareils de mesure de la pollution de l'air,
 - le contrôle par échantillonnage,
 - l'effet de la température et de l'évaporation dans le mesurage des hydrocarbures,
 - la mesure de la radioactivité,
- sujets qui sont toujours d'actualité.
- 1962 Deuxième Conférence Internationale à Vienne. M. STULLA-GÖTZ est élu Président du CIML.
- 1964 Le besoin de place s'étant fait sentir, le BIML déménage pour occuper son siège actuel, 11, rue Turgot, 75009 Paris. Le personnel comprend maintenant M. ALLWRIGHT, adjoint, Mlle ROBBE, secrétaire, M. LECLERCQ, documentaliste.

1er septembre 1964 : Accord de Siège

Signature de l'accord relatif au siège de l'OIML et à ses privilèges et immunités sur le Territoire Français.

- 1968 Troisième Conférence Internationale à Paris. M. van MALE est élu Président du CIML. Il sera réélu en 1974.
- 1972 Quatrième Conférence Internationale à Londres.
- 1974 Le Directeur du BIML M. COSTAMAGNA, qui depuis 1937 a été le pilier et le promoteur de l'OIML, a pris sa retraite. Il est remplacé par M. ATHANÉ et M. REFEROWSKI est nommé adjoint.

- 1976 Cinquième Conférence Internationale à Paris.
- 1980 Sixième Conférence Internationale à Washington. M. BIRKELAND est élu Président du CIML.
- 1984 Septième Conférence Internationale à Helsinki.
- 1985 L'OIML comprend 50 Etats Membres, 26 Membres Correspondants, 180 groupes de travail internationaux. Sept Conférences Internationales et 20 réunions du Comité ont été tenues. Un vocabulaire, 73 Recommandations Internationales, 10 Documents Internationaux et de nombreuses autres brochures ont été publiés ; le BIML comprend 9 Agents* ; son budget est de l'ordre de 4 000 000 FRF ; le Bulletin de l'OIML fête son numéro 100.



Signature de l'Accord de Siège, le 1er septembre 1964, par M. François LEDUC, Ministre Plénipotentiaire et M. Josef STULLA-GÖTZ, Président du CIML

(*) MM. ATHANE, Directeur, THULIN et PETIK, Adjointes au Directeur, TURSKI, Ingénieur Consultant, LECLERCQ, Administrateur, Mlle ROBBE et Mme CHASSELOUP, Secrétaires, MM. CAURO, Documentaliste, BOURGEOIS, Archiviste.

30 YEARS of OIML

The publication of Number 100 of the OIML Bulletin coincides with the 30th anniversary of the signature, in Paris on 12 October 1955, of the Convention instituting the Organisation Internationale de Métrologie Légale.

The idea of creating an international organ in the field of practical and legal metrology is however much older. In fact an official proposal was already formulated in 1913 and was no doubt preceded by numerous discussions.

As some of the founders of OIML have already passed away, the BIML has thought it appropriate to preserve a written trace of the events of the preceding decades.

The long history of OIML remains however to be written and we can, in this anniversary issue, simply recall the significant facts in a brief chronology :

1875 Meter Convention and creation of the Bureau International des Poids et Mesures.

1913 The Fifth General Conference of Weights and Measures passes the following Resolution :

« The General Conference requests the International Committee to examine the proposal of the Italian Government with a view of creating between interested States an agreement on the choice of instruments to be subject to official verification and on the prescriptions to be laid down for this verification with the aim of permitting subsequent exchange of such instruments between different countries ».

The Romanian Delegation proposes in this spirit « a meeting between Directors of Weights and Measures of the different countries which could prepare an agreement on these questions ».

1933 Eighth General Conference of Weights and Measures :

Resolution 15 : Study of the creation of a Consultative Committee of Practical Metrology.

« The Conference having received a proposal by the U.S.S.R. Delegates aiming at the constitution of a Consultative Committee of Applied Metrology attached to the International Committee of Weights and Measures, instructs the International Committee to examine this question » .

1937 World Fair in Paris ; France is celebrating the Centenary of the creation of its Weights and Measures Service. Responding to the wish of the General Conference of Weights and Measures the French Government has decided to call the First International Conference of Practical Metrology. The resolutions proposed by the French, Polish, Romanian and Yugoslav Delegations and adopted at the Conference form the base of the future OIML.

A provisional Committee of Legal Metrology is created under the Presidency of Mr RAUSZER and Mr COSTAMAGNA is nominated secretary.

1938 The Provisional International Committee of Legal Metrology planned to meet to in 1938 and the Ninth General Conference of Weights and Measures in 1939.
1945 The international events which lasted until 1945 prevented any meeting or other activity.

1950 Meetings in Paris and Brussels of the Provisional International Committee of and Legal Metrology under the Presidency of Mr JACOB. The text of the Convention
1952 instituting OIML starts to take shape.

The future cooperation with ISO, IEC, UNESCO... and of course with BIPM is discussed. The Secretariat which now has become practically permanent is still ensured by Mr COSTAMAGNA. Among the other active personalities one notes the names of Messrs BEFAHY, KÖNIG, POPPY, STULLA-GÖTZ, VIAUD, VIEWEG...

- 1954 An informative meeting of the Provisional International Committee of Legal Metrology is called on the occasion of the Tenth General Conference of Weights and Measures. The creation of OIML as an intergovernmental organisation, independent of both BIPM and the United Nations, is virtually accepted by many countries.

12 October 1955 : 22 States have signed the Convention

- 1956 The First International Conference of Legal Metrology takes place in Paris. 23 Member States, 3 Corresponding States, 4 Observer States and 6 International Institutions are present. In addition to the personalities already mentioned one notices the names of two present CIML members : Messrs LIERS and MÜHE. Mr JACOB is elected President of CIML.
- 1959 The International Bureau of Legal Metrology which was previously housed by the French Administration moves to its own premises at 9, avenue Franco-Russe, Paris 7ème. Its staff is composed of Mr COSTAMAGNA, Director, Mr JASNORZEWSKI, Assistant Director, Mrs HOUDOUIN, secretary soon joined by Mr CAURO, documentation clerk.
- 1960 The CIML holds its 3rd meeting. The Bulletin of OIML is created. The work programme comprises some 70 subjects which include the following :
- electronic weighing instruments,
 - indication of mass and volume on prepackages,
 - air pollution measuring instruments,
 - control by sampling,
 - influence of temperature and evaporation on measurements of hydro-carbon products,
 - measurement of radioactivity.

These subjects are still of great interest.

- 1962 Second International Conference in Vienna. Mr STULLA-GÖTZ is elected President of CIML.
- 1964 BIML needing more space moves to its present premises at 11, rue Turgot, 75009 Paris. The staff now also comprises Mr ALLWRIGHT, Assistant Director, Miss ROBBE, secretary, Mr LECLERCQ, documentation clerk.

1er September 1964 : Agreement on OIML Headquarters

Signature of the agreement concerning the OIML Headquarters and its privileges and immunities within the French Territory.

- 1968 Third International Conference in Paris. Mr van MALE is elected President of CIML. He will be re-elected in 1974.
- 1972 Fourth International Conference in London.
- 1974 The Director of BIML, Mr COSTAMAGNA has retired after having been the pillar and promoter of OIML since 1937. He is replaced by Mr ATHANÉ and Mr REFEROWSKI is nominated Assistant Director.

- 1976 Fifth International Conference in Paris.
- 1980 Sixth International Conference in Washington. Mr BIRKELAND is elected President of CIML.
- 1984 Seventh International Conference in Helsinki.
- 1985 The OIML comprises 50 Member States, 26 Corresponding Members, 180 International Working Groups. Seven International Conferences and 20 CIML meetings have been held ; one Vocabulary, 73 International Recommendations, 10 International Documents and a number of brochures have been published. The BIML has a staff of 9 *, its annual budget is of the order of 4 000 000, FRF. The Bulletin of OIML celebrates its number 100.

(*) Messrs ATHANE, Director, THULIN and PETIK, Assistant Directors, TURSKI, Consultant Engineer, LECLERCQ, Administrator, Miss ROBBE and Mrs CHASSELOUP, Secretaries, Messrs CAURO, Documentation clerk, BOURGEOIS, Filing clerk.

CUBA

VERIFICATION of HEAVY WEIGHING MACHINES USING MOBILE MASS LABORATORIES

by **Pedro G. CAMARA CAMINO**

Vice-Director of the Metrology Research Institute (INIMET)

SUMMARY — This article describes briefly the mobile units used in the Republic of Cuba for the verification of high capacity weighing machines.

RESUME — Cet article décrit brièvement les camions étalons utilisés à Cuba pour la vérification des ponts bascules de portée élevée.

In the efforts made by our Country in order to overcome sub-development, the mass measurements represent an important field and are more and more necessary for the progress of our industry and for the increase of our international trade.

This is the reason why our Governmental Metrology Service Organs have during the last six years expanded the verification of high capacity weighing machines up to 200 t by the use of three mobile laboratories of mass. Each one of them consists of a lorry (fig. 1) carrying a set of standard weights as indicated in Table 1.

The staff of each of these laboratories is composed as follows :

- 1 metrology technician (Chief of the Mobile Mass Laboratory),
- 1 repairman of measuring instruments,
- 2 drivers of the lorry.

These three mobile units have their bases located in the territorial metrology laboratories of the Governmental Metrology Service, from which they offer verification services to the relevant provinces (see Fig. 2) by following an annual verification plan.

All rail and road weighbridges are subject to mandatory verification, for which we have elaborated eleven governmental standards on methods and means of verification and we have four in course of elaboration (see Annex 1 and 2).

The weighing machines with a measuring range lower than 25 t are verified by direct load and the ones that have a measuring range higher than 25 t are verified by tare-weight. When the measuring machines are declared not suitable for use because they have errors greater than the maximum permissible errors stated in the corresponding Cuban standard, we make readjustments and small repairs by the mechanic which belongs to the personnel of the mobile mass laboratory and they are verified once again until the best functional state is obtained.

With the development of this service we can realize periodic verifications of weighing machines up to 200 t, giving Metrological Assurance in this quantity in different branches of our economy such as : sugar mills, bulk sugar installations, siderurgy, agriculture, freight stations and others.

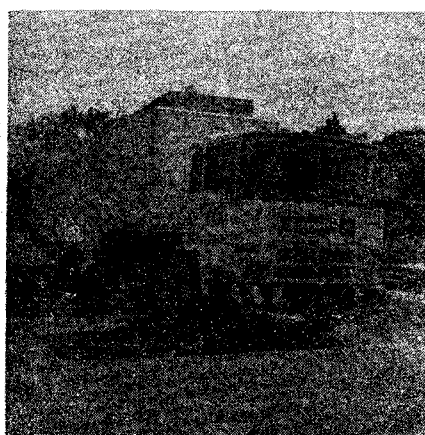


Fig. 1 — Mobile mass laboratory comprising a lorry carrying 1 000 kg test weights which can be unloaded from the side using a fork lift

Table 1 — Weights carried by the mobile mass laboratories

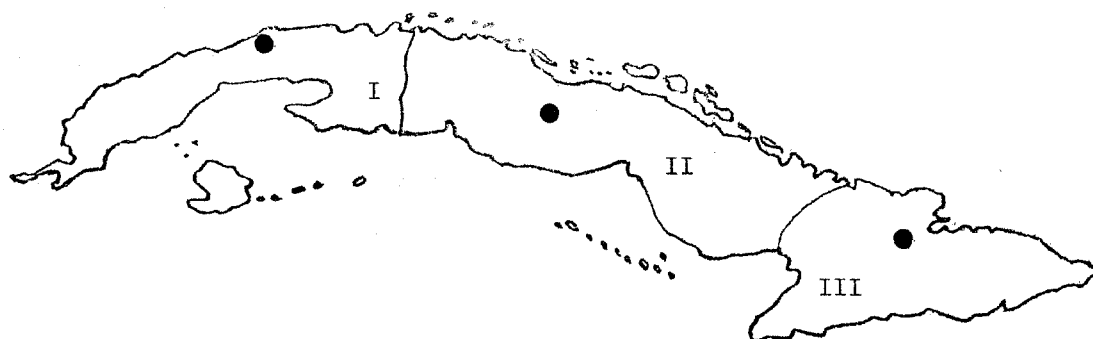
Quantity of Standard test weights	Nominal Value	Maximum permissible error
24	1 t	± 100 g
50	20 kg	$\pm 1\,600$ mg
2	10 kg	± 800 mg
2	5 kg	± 400 mg
2	2 kg	± 160 mg
2	1 kg	± 120 mg
2	box of 1 to 500 g	$\pm (80 \text{ to } 4 \text{ mg})$

The realization of these achievements has been possible thanks to research work by a group of metrology engineers which are working in the Metrology Research Institute (INIMET).

This work permitted the construction in the local mechanical industry of two of the mobile laboratories to transport the standard weights and the casting of 48 weights of 1 t according to the international requirements and which can be certified with a maximum permissible error of ± 100 g.

The new equipment permits us to meet the needs in respect of legal metrology for commercial transactions on both national and international levels.

TERRITORIAL DISTRIBUTION OF THE MOBILE LABORATORIES



Territorial Metrology Laboratory of	District	Provinces covered by this service
Ciudad Habana	I	Pinar del Río Habana Ciudad Habana Matanzas
Villa Clara	II	Villa Clara Cienfuegos Sancti Spiritus Ciego de Avila Camagüey
Holguín	III	Las Tunas Holguín Granma Guantánamos Santiago de Cuba

Fig. 2

ANNEX 1

Cuban Standards in use

NC 90-06-07:82	Metrological Assurance. Roman Counter Balances. Verification Methods and Means.
NC 90-06-09:83	Metrological Assurance. Platform Roman Balances for General Use. Verification Methods and Means.
NC 90-06-14:80	Metrological Assurance. Dial Balances. Verification Methods and Means.
NC 90-06-20:81	Metrological Assurance. Two-Pan Counter Balances with Mass Measures. Verification Methods and Means.
NC 90-06-21:81	Metrological Assurance. Balance-Bar and Sliding Block Scales for trucks. Verification Methods and Means.
NC 90-06-23:81	Metrological Assurance. Dial Scales for Trucks. Verification Methods and Means.
NC 90-06-24:81	Metrological Assurance. Balance-Bar and Sliding Block Scales for Rail Wagons. Verification Methods and Means.
NC 90-06-25:81	Metrological Assurance. Dial Scales for Rail Wagons. Verification Methods and Means.
NC 90-06-29:83	Metrological Assurance. Dial Scales for General Use. Verification Methods and Means.
NC 90-06-31:82	Metrological Assurance. Suspended Roman Balance. Verification Methods and Means.
NC 90-06-34:84	Metrological Assurance. Dial Roman Balances for General Use. Verification Methods and Means.

ANNEX 2

Draft Cuban Standards

NC 90-06-33	Metrological Assurance. Multiple-Range Counter Scales. Verification Methods and Means.
NC 90-06-37	Metrological Assurance. Beam Crane Scales. Verification Methods and Means.
NC 90-06-38	Metrological Assurance. Monorail Scales. Verification Methods and Means.
NC 90-06-39	Metrological Assurance. Measuring Instruments for Parts Counting. Verification Methods and Means.

MASS COMPARATOR for IN-SITU CALIBRATION of LARGE MASS STANDARDS *

by R.M. SCHOONOVER

Length and Mass Division, National Bureau of Standards, USA

SUMMARY — *The transportable mass comparator described uses a suspended strain-gauge load cell which is maintained at approximately constant load by a system of springs so as to avoid creep. Mass comparisons with a resolution of 1 part in 10^6 are possible with this device which has been constructed for loads up to 5 000 kg.*

RESUME — *Les masses de forte portée utilisées pour la vérification des ponts-basculés posent des problèmes de transport lorsqu'il est nécessaire de les faire venir dans un laboratoire de métrologie pour leur étalonnage ou ajustage. Ceci peut être évité en utilisant le comparateur de masse facilement transportable décrit par l'auteur. Ce comparateur utilise un capteur de force à jauges de contrainte maintenu à charge constante par un système de ressorts de façon à éviter l'effet de fluage du capteur. Des comparaisons de masse avec une résolution de 1 sur 10^6 sont possibles à l'aide de ce dispositif qui a été construit pour des charges allant jusqu'à 5 000 kg.*

Introduction

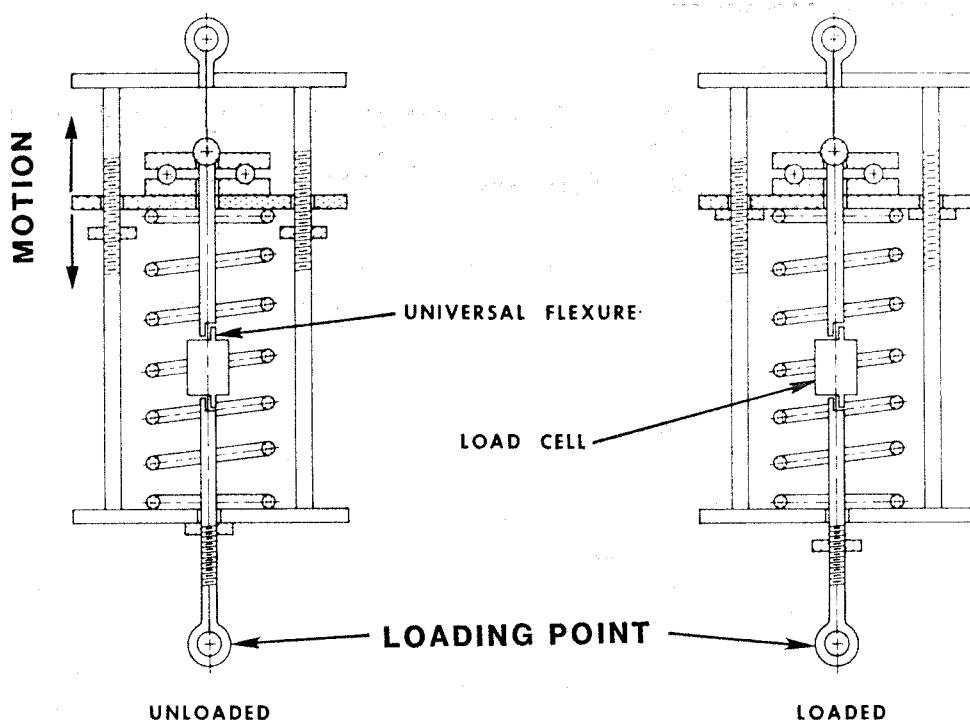
In many laboratories around the world there are large dead weight testing machines used for calibrating strain gage load cells, proving rings, and other force transducers. Usually a special balance or scale for reverification of the dead-weight mass values is available should the need arise. If not, then on occasion the machine may have to be disassembled and transported to a laboratory where appropriate mass standards and weighing machines exist.

In the United States, and probably in most countries, the transportation of large mass standards, weighing many thousands of kilograms, is a daily occurrence. Usually these mass standards are in the nature of scale test weights for which the user does not need a mass value which is accurate to a few parts per million, but must only be assured that his weights are within a specified tolerance to meet the legal requirements for commerce. The tolerance placed on these test weights is approximately 1 part in ten thousand. The following discussion describes a new portable electronic mass comparator. This unit can easily be transported, along with a suitable mass standard, to any site where reasonable weighing conditions exist, allowing relatively rapid and inexpensive verification of a collection of weights.

The mass comparator

Although the mass comparator is well described in the literature [1], [2], [3], [4] a brief description of the unit and how it operates will be useful for those not familiar with the principles.

* Presented at the OIML Seminar on Testing of Bulk Weighing Installations, Paris 22-25 April 1985.



LOAD CELL MASS COMPARATOR

Fig. 1 — Principle of constant load mass comparator

First, as the name implies, the device is either a mass comparator or a force comparator. Since the local acceleration of gravity affects equally the mass standard and the test weight, the masses can be compared directly (assuming the displacement volumes are equal). This comparison could be made on any strain gage load cell. However, since the resulting measurement may not be accurate to within 1 part in 10 000, one could not state with assurance whether the measured test weight is in or out of tolerance.

Because a load cell has the desirable features of portability, electric signal output, small size, and the possibility of battery operation, it would be highly useful if the following disadvantages could be overcome :

- 1) Hysteresis,
- 2) Creep,
- 3) Sensitivity to off-axis loading,
- 4) Sensitivity to torque loading,
- 5) Unbalanced bridge self-heating,
- 6) Sensitivity to barometric pressure variations.

The first two items on the list, hysteresis and creep, are circumvented by the most important principle of the mass comparator, which is a constant loading of the load cell at all times, even during the period when the mass standard and the test weight are being exchanged. This is accomplished with a servomechanism [1] that uses coiled springs in tension to supply the force required to automatically maintain a constant load on the cell even when the equivalent mass load is in the process of changing. Figure 1 demonstrates this principle.

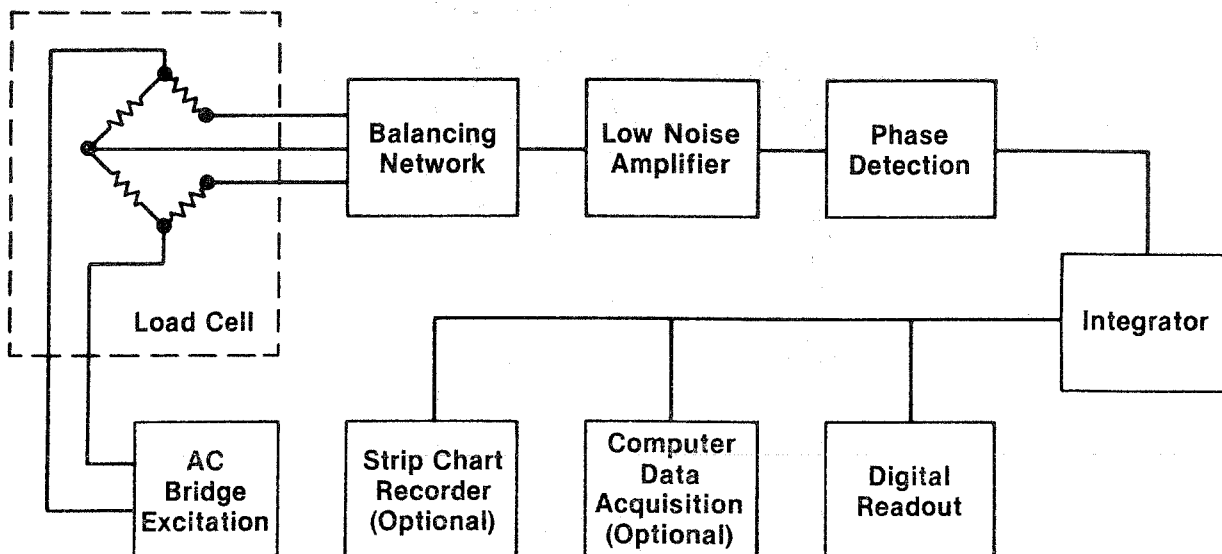


Fig. 2 — Schematic diagram of the electronic measuring system

The next two items on the list, sensitivity to off-axis loading and sensitivity to torque loading can be eliminated by the placement of high-quality universal joints above and below the cell and a good-quality, robust thrust bearing at the load connecting point. These serve to keep the load axially aligned through the cell and eliminate torque that might otherwise be imparted to the cell during loading and unloading of the weights.

The last two disadvantages on the list can be avoided by fabricating a load cell and strain gage dedicated for use as a mass comparator and not as a direct-reading load cell. The bridge in an ordinary load cell is usually balanced when unloaded and goes progressively out of balance as the cell is loaded to capacity. This out-of-balance condition causes heating in the transducer and makes the measurement of very small electrical signal differences between two large signals more difficult. This out of balance condition can be corrected with an external bridge [4]. However, this situation lacks symmetry, and the comparator becomes very sensitive to thermal changes in the weighing environment. The best solution to the problem is to install a bridge that can be balanced for any applied load. Such a circuit is shown in figure 2. Not only is it symmetrical but lends itself well to sophisticated schemes for measuring very small signal differences between applied loads.

Because the unbalance signal levels are quite small (0.01 microvolt) a clean, dry, bridge environment is required. However, unlike the direct-reading load cell for which long term stability (load vs. output) is desirable, it is not necessary to seal the cell with a dry gas thereby making the transducer sensitive to barometric pressure changes. We need only keep the bridge clean and dry. When in use, the internal cavity of the load cell is exposed to ambient pressure via a vent hole and filter-dessiccant package.

Although battery operation makes the comparator more versatile it is not essential. However, battery operation along with a chopper stabilized amplifier is desirable when such small voltage levels are measured. The circuits that measure these small voltages are sensitive to power line variations and electrical noise found in many industrial facilities. Battery operation eliminates the problem and makes the instrument truly portable. However, a hybrid system is usually more desirable since the partial use of house power allows for a brighter digital display and computer interfacing, both of which place a heavy power drain on rechargeable battery packs.

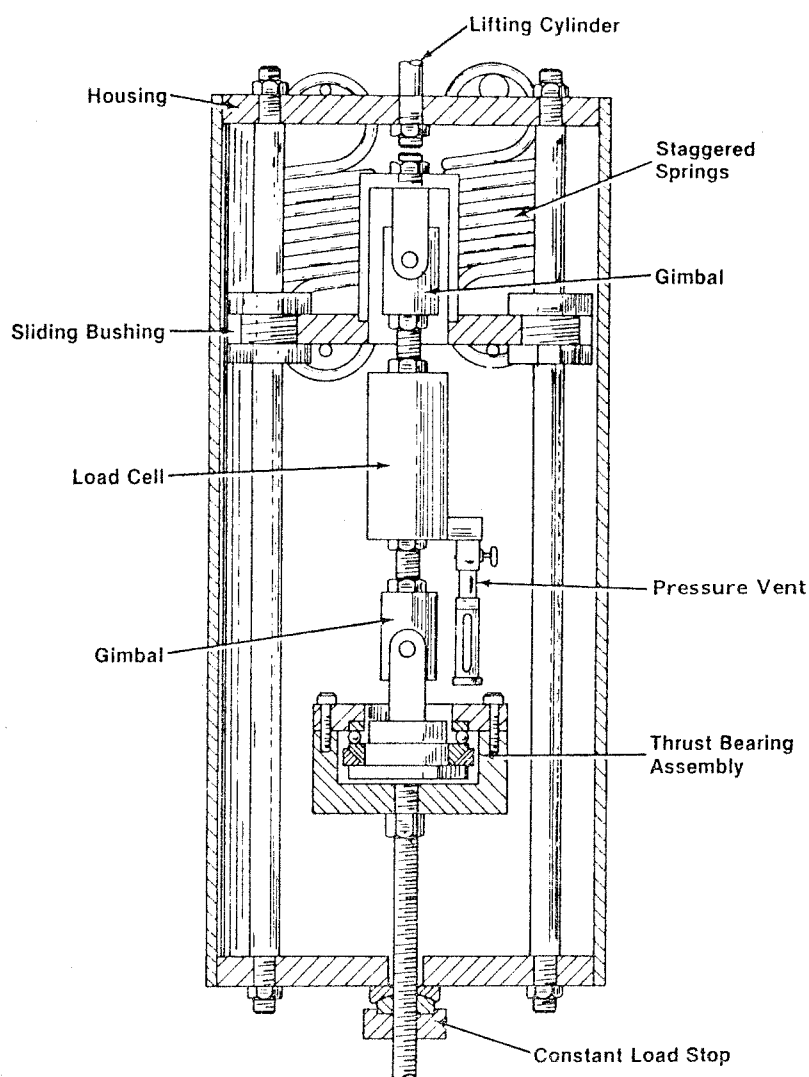


Fig. 3 — Schematic diagram of the mechanical part of the mass comparator

Figure 3 shows the completed mass comparator schematically. The unit has four negative springs in tension with staggered engagement to shorten the overall package length. Connected to the top of the comparator is a hydraulic cylinder for lifting the comparator a small amount thereby lifting any attached test weight slowly from its resting position and gently loading the comparator. Figure 4 illustrates the principle.

In-situ weighing

It would seem that we would need only to carry the mass comparator and a mass standard to an area suitable for weighing to a few parts in one hundred thousand (for tolerance testing) and proceed with an appropriate comparison scheme. However, we would soon discover the need for a traveling support for the comparator such as an overhead crane or a means to move the weights beneath the comparator.

At the parts-per-million level of precision the system performs better when the comparator is suspended from a fixed point and the standard and test weight are placed directly below the load point. However, with care the performance is not badly degraded when the comparator is moved on a crane from one weight to the next. Thus we have a choice in the weight handling system to be used.

Figure 6 shows a typical crane mounted system for testing 500 kg test weights in the standards laboratory of the state of Illinois. The standard is picked up and the indicator is set to zero, assuming that the standard has no correction. Immediately following this, in a uniform time sequence, other weights are picked up and any differences from the mass standard are noted. After testing five weights, the operator returns the comparator to the standard and notes the indication. If a drift has occurred it is assumed to have been linear with time and the test weight observations are then corrected based on a uniform time sequence as follows :

$$O'_{xi} = O_{xi} + \frac{(O_N - O_1)(t_{xi} - t_1)}{t_N - t_1}$$

where O_1 and O_N are respectively the first and last observations of the standard, and t_1 and t_N are the corresponding times. O_{xi} and t_{xi} are respectively the observed mass difference and the time for each test weighing, and O'_{xi} is the difference corrected for drift.

Using the scheme of Figure 4 or any suitable method we could mount the comparator at a fixed position and move the standard and test weights to the comparator. This method works well with a track-and-dolly system shown schematically in figure 5 for weights of 1 000 kg or less. When larger loads are encountered, (5 000 kg), an air supported cart such as shown in figure 6 is very useful. Here all that is required besides the cart and its power unit is a flat, smooth concrete floor and some temporary guide rails.

It should be noted that there are many algorithms in use to establish whether or not mass values are in tolerance. The algorithm discussed here is only one example of how the substitution weighing could be performed. The method chosen is largely dependent on the comparator's zero stability and the weighing environment. Some weighing environments undergo large and rapid temperature excursions. For those conditions, the above example would not be the one of choice. It may be possible to weigh outdoors with this device if adequate protection from the sun and wind are provided. When more than a simple tolerance test is desired, as in a mass value assignment, then more elaborate comparison methods may be required along with more stringent environmental controls.

Other applications

The figures demonstrate the portability and in-situ weighing capability of the load cell mass comparator. Figure 7 demonstrates the usefulness when weighing a mass of extraordinary geometry. The 500-kg weight cart shown here is undergoing a calibration that cannot be performed on most large equal arm balances because of its shape. Similar situations occur when weighing uranium hexafluoride shipping containers or during weighings used in some volumetric determinations.

Two features of the load cell that has not yet been mentioned are its constant sensitivity and linearity over a restricted portion of its capacity. These features can be combined to build a comparator with part-per-million reproducibility and a capacity of from 250 kg to 5 000 kg, and which can tolerate differences as large as ± 1 kg between the mass standard and the test weight. By changing a switch in the electronic circuit, the comparator changes reproducibility from 1 to about 20 parts per million and likewise can now tolerate differences of ± 10 kg between two weights. A third switch position allows for this progression to occur a third time. This feature makes

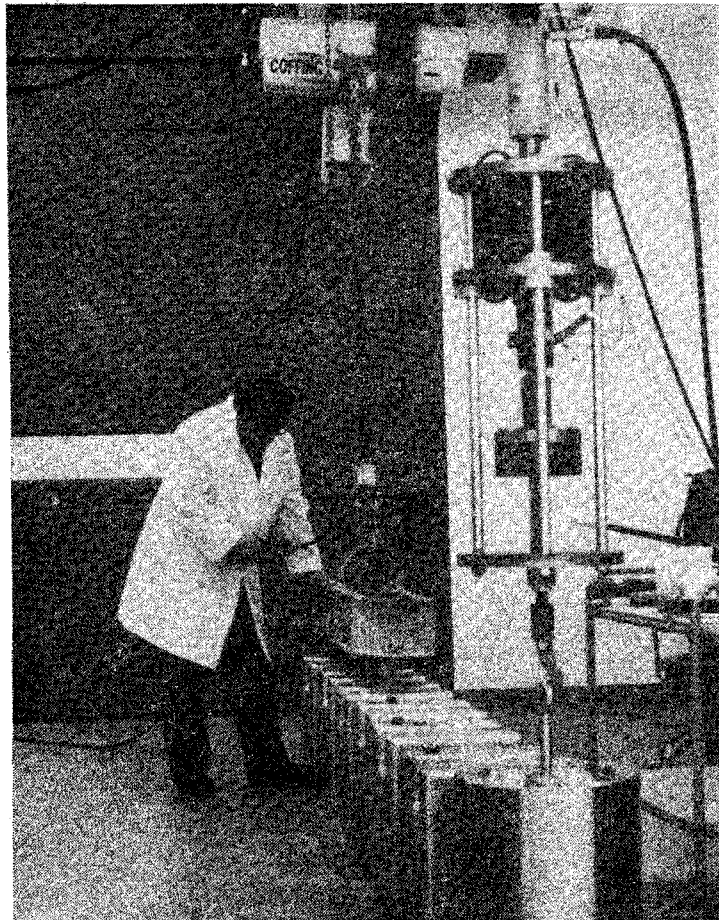


Fig. 4 — Mass comparator in use showing the hydraulic lifting cylinder at the top. The comparator is here suspended from a moving crane.

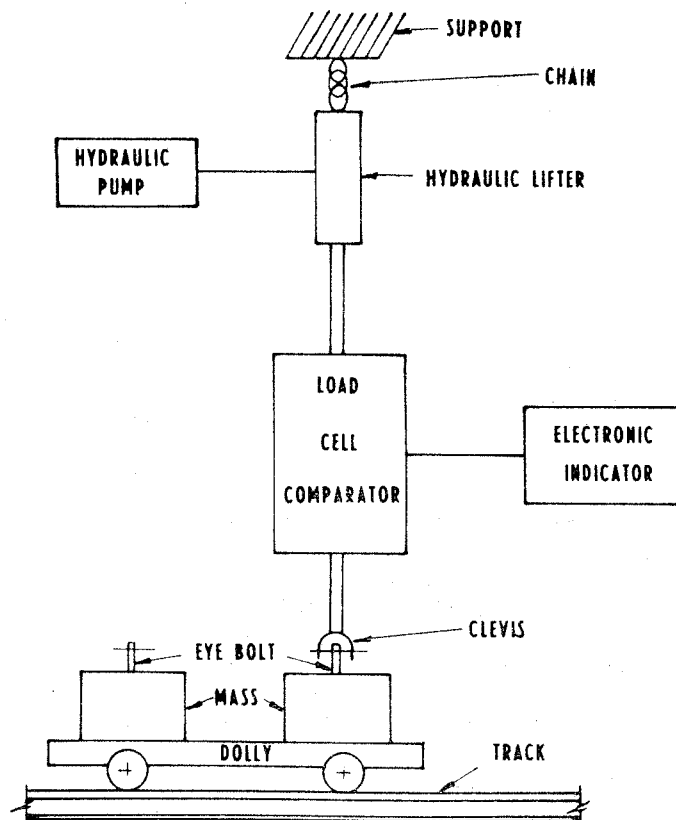


Fig. 5 — Comparator used in a fixed position with a cart to move the tested weights

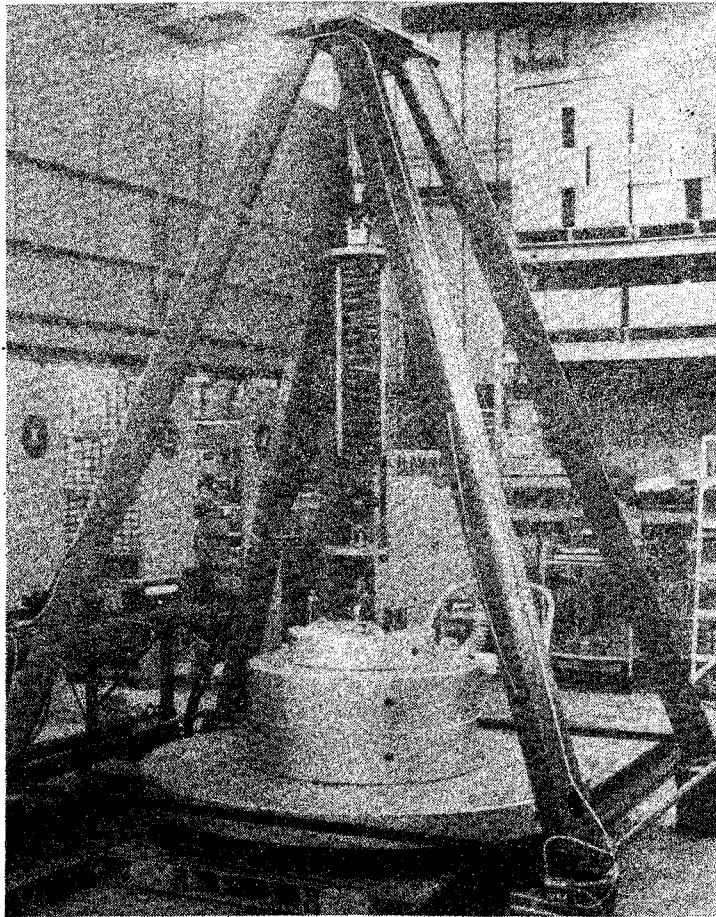


Fig. 6 — Air supported cart for 5 000 kg weights

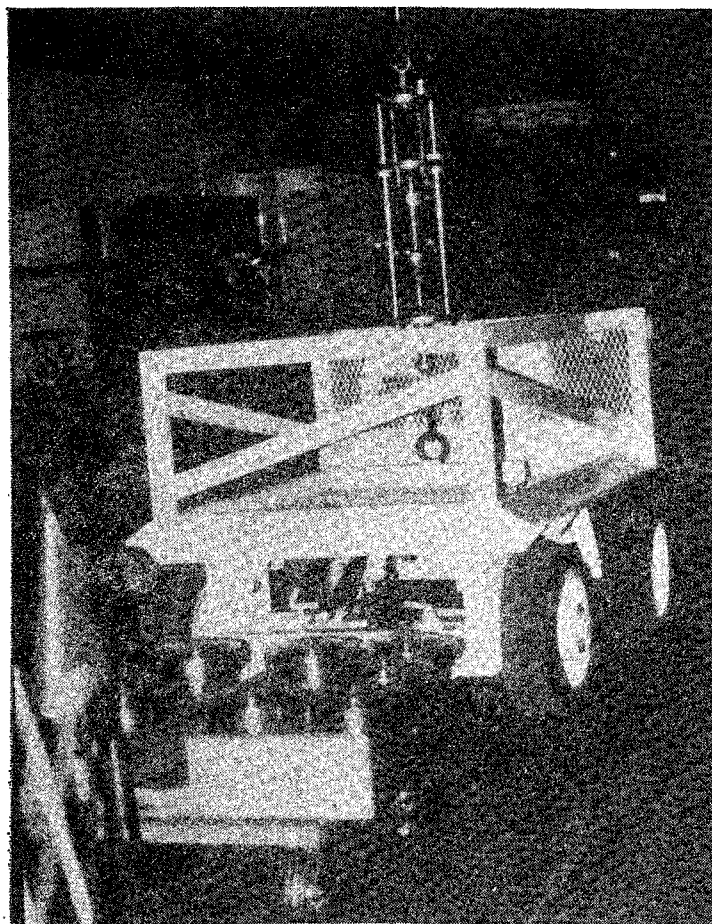


Fig. 7 — Weighing of a 500 kg cart

the comparator extremely useful when test weights are reconditioned. For re-conditioning, the adjustment cavities are first opened. The mass is then trimmed into tolerance by adding or removing material and then resealing the cavity. During this procedure the large « on scale » range and fast response time will often permit the mass readjustment and tolerance testing to occur simultaneously.

Conclusion

Development of the load cell mass comparator has made it possible to transport a highly reproducible mass comparator to large collections of weights that require calibration. Although several of the commercial units as well as several private units are in operation, no one has used it to perform in-situ measurements. Recent communication with the principal metrologist for the State of California indicates that California will soon undertake this program on a routine-service basis. Clearly the California program and its outcome will be of great interest to those of us engaged in mass calibration.

References

- [1] Schoonover, Randall M., A high precision load cell mass comparator, J. Res. Nat. Bur. Stand. (U.S.), **84** (5), September-October 1979, pp. 347-351.
- [2] Schoonover, Randall M., A 30 kg capacity high precision load cell mass comparator, J. Res. Nat. Bur. Stand. (U.S.) **87** (1), January-February 1982, pp. 47-48.
- [3] Page, Dennis, A high precision load cell comparator for large mass, ISA Transactions, Vol. 22, No. 2, 1983, pp. 31-47.
- [4] Schoonover, Randall M., A large capacity high precision electronic mass comparator, Proceedings of the 10th Conference of IMEKO TC3 on Measurement of Force and Mass, Kobe, Japan, September 1984, pp. 101-104.

PISTON PROVER PRIMARY STANDARD for HIGH-PRESSURE GAS METERING

by H. BELLINGA (1), C.P. HOEKS (2), A. KOOI (1), F.A.L. Van LAAK (3)
and P.J. ORBONS (4)

SUMMARY — The piston prover described in this paper has been developed by the Aethylen Rohrleitungs-Gesellschaft (ARG) in cooperation with DSM, a Dutch chemical industry company.

The measuring volume of the prover has been determined by DSM using water. The Dutch Service of Legal Metrology (IJkwezen) has tested the prover with water and has approved it for use as a standard instrument.

The tests with water showed that the piston prover might also be used to calibrate gas meters at higher pressure. The results of the calibration of two meters, a turbine meter and a Constant Volume Meter (CVM), with natural gas using the piston prover as a reference were in excellent agreement with the results of calibration of the same meters with the high-pressure test installation in the laboratory of Gasunie in Groningen, the Netherlands.

RESUME — Le tube étalon pour mesures des gaz décrit dans cet article a été construit par l'Aethylen Rohrleitungs-Gesellschaft (ARG) en coopération avec DSM, une société néerlandaise de chimie industrielle.

Le volume du tube a été déterminé par DSM en utilisant de l'eau. Le Service néerlandais de métrologie (IJkwezen) a vérifié le tube et a donné l'approbation pour son utilisation en tant qu'instrument étalon.

Les essais avec de l'eau ont montré que ce tube étalon peut également servir à l'étalonnage de compteurs de gaz à pression plus élevée (60 bars).

Introduction

The Aethylen Rohrleitungs-Gesellschaft (ARG) is a pipeline company operating a 10" ethylene pipeline with a total length of about 440 km under a pressure of 60-100 bar. The line connects the German Ruhrarea with the Antwerp docks, via the Netherlands. Nineteen chemical industries are connected directly to the grid, and fifteen companies are connected to it via other pipelines. ARG functions as a common carrier, transporting ethylene from suppliers to users on a contract basis. Ethylene losses, including losses due to inaccurate measurement, are to the account of ARG. In view of the high price of ethylene, the availability of an accurate measuring system is very important for ARG. For quantity measurement, the company at present requires the use of two turbine meters in series. The meters are equipped with pulse generators which produce a pulse each time a rotor blade passes a proximity switch. The calibration curve of the turbine meter is programmed in the electronic counter. In order to be able to correct for the meter error, the complete curve should

(1) Gasunie Company.

(2) IJkwezen (Dutch Service of Legal Metrology).

(3) DSM Company.

(4) ARG Company.

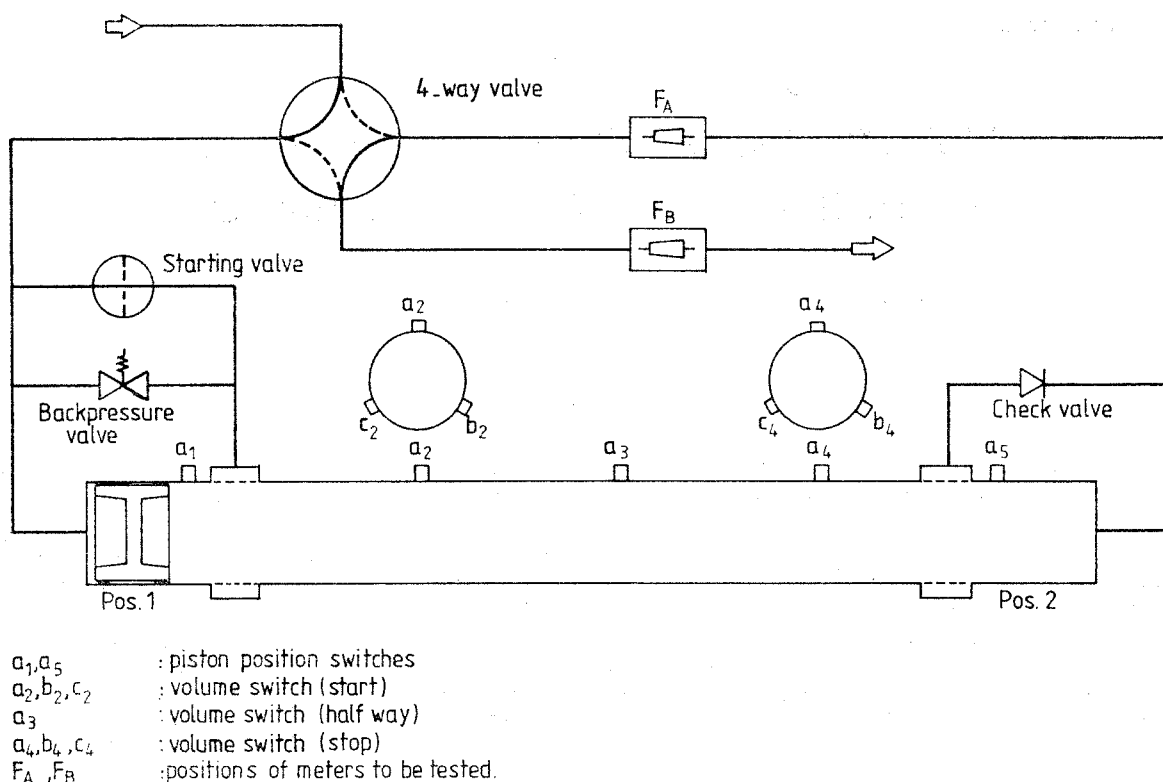


Fig. 1 — Piston prover developed by ARG

be accurately known, which means that the curve must be determined under operating conditions, using ethylene as the testfluid. The most direct method to do this is by means of a prover under operating conditions.

In Europe, no manufacturer was found who could provide a prover meeting the ARG requirements at a reasonable price. Three USA manufacturers were visited. Only one seemed to have an attractive offer, but tests showed that the prover concerned had a flow-rate dependent measuring volume, which could not be explained. Therefore, the only solution left to ARG was to investigate whether it could develop a suitable prover itself.

At that time, DSM was investigating the applicability of prover loops, mainly to calibrate flow measuring equipment for pilot plants. Measurements were done at the piston seals to obtain insight into leakage, friction and launching phenomena. The tests were carried out with air to determine how the prover should be dimensioned to ensure uniform velocity of the piston throughout its travel between the detectors of the measuring section. The tests showed that it was possible to design a prover for gas applications. At present, two DSM provers are used to calibrate liquid meters: a 2" prover for flow rates of up to about 2 m³/h and a 6" prover for flow rates up to about 30 m³/h. By order of ARG, tests were carried out on the reproducibility, velocity-dependency and temperature-dependency of the electronic proximity switches marking the measuring volume. The results of all these measurements justify the conclusion that it is at least technically feasible to design a relatively short piston prover of the classical type, i.e. with a freely moving piston, for gas applications.

The NV Nederlandse Gasunie is a large-scale purchaser, transporter and seller of natural gas within the Netherlands. Product quantity measurement takes place at the inlet of the pipeline system as well as at the various take-off points. At the

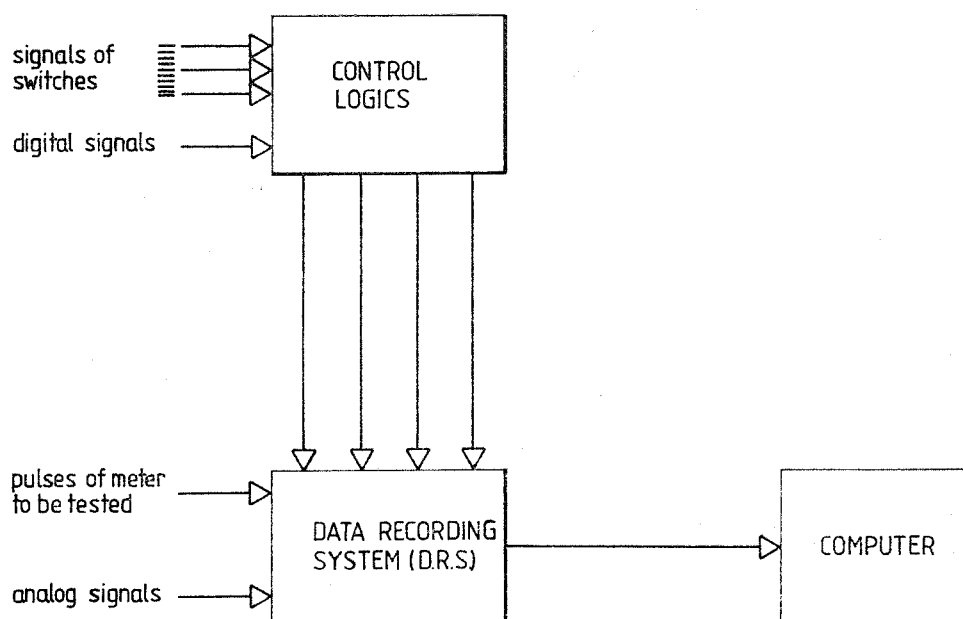


Fig. 2 — Block diagram of the electronics

inlet, the measuring devices are standardized orifice plates. At take-off points in the Netherlands, calibrated turbine meters are used. The meters are calibrated at operating conditions with the Gasunie high pressure test facilities in Groningen, Bergum and Westerbork. A test facility, in Utrecht for a gauge pressure of 8 bar is owned by a Dutch meter manufacturer. All of these facilities are traceable to the international mass standard. The calibrations are carried out by IJkwezen.

The procedure to realize a high pressure reference meter is time consuming and involves many steps each of which introducing its own uncertainty. By application of a piston prover, the procedure can be considerably shortened, and the uncertainty reduced.

Description of the piston prover

In developing a prover for ethylene meters, the following criteria were used :

- the measuring pipe should be made of a single piece of material ; welded connections and flange connections may adversely affect the uniformity of the piston velocity.

- when the piston starts to move, a pressure wave occurs. In order to allow this wave to disappear, part of the total length of the pipe should be used as a launching section.

- the pipe should have exactly the same diameter throughout its length, to keep the pressure differential across the piston, and hence the piston velocity, constant during the run.

- the length of the measuring section can be short since experiments have shown that the reproducibility and the stability of the switches are good.

- the measuring volume does not need to be large, since application of a sophisticated pulse interpolation technique yields sufficient accuracy [1].

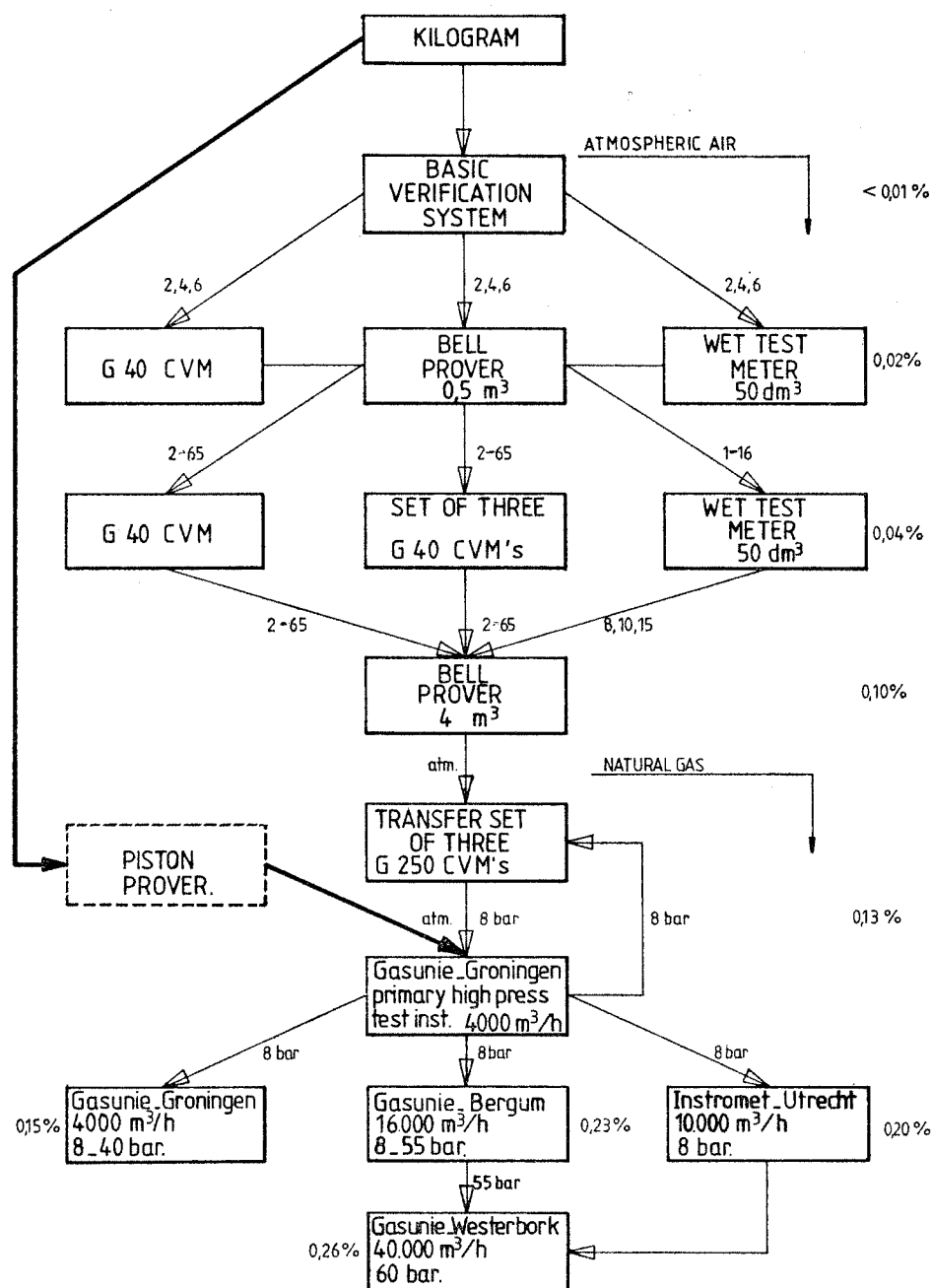


Fig. 3 — Traceability chart of the test facilities

The piston prover is made of 316 SS stainless steel, which is available in bars with a maximum length of 6 m. The measuring cylinder was made out of one 6 m bar. The inside diameter chosen is 250 mm, and it was decided to make the length of the measuring section between the detector switches 3 metres. Furthermore, it was decided to use the prover unidirectionally and not to measure during the return stroke of the piston, so that the measuring section is not to be exactly midway between the cylinder ends. Thus, a 2-metre launching section without obstructions is available.

Further specifications are summarized in Table 1.

TABLE 1

The complete specifications are as follows :

Piston	:	freely moving
Cylinder length	:	6 m
Length of long measuring section	:	3 m
Length of short measuring section	:	1.5 m
Length of launching section	:	2 m
Cylinder diameter	:	250 mm
Cylinder material	:	316 SS
Piston material	:	aluminium, with 316 SS switch-actuating rings
Piston carrier ring material	:	graphited Teflon
Piston seal material	:	graphited Teflon (Kapseals)
Detector switches	:	electronic proximity switches
Measuring volume	:	147.41 dm ³

For application in supercritical ethylene, the following data are valid :

Flow rate	:	0.5-250 m ³ /h
Nominal pressure	:	ANSI 600 lbs
Temperature	:	0-50 °C
Pressure drop across piston	:	0.07-0.14 bar
Connections	:	4" ANSI 600 lbs RF

The piston prover is equipped with three pairs of switches (a_2 - a_4 , b_2 - b_4 , c_2 - c_4), so that there are three measuring volumes. All three pairs of switches are used during a proving run. This means that in one run the prover gives three meter factor values. The difference between these values should be very small. If one of the values deviates, a switch is defective. After replacement of the defective switch, the measuring volume must be determined anew ; with the aid of a turbine meter and the two known measuring volumes, the third measuring volume can be derived. Figure 1 schematically shows the prover set-up.

The meters to be calibrated can be incorporated into the system upstream or downstream the four-way valve. The rotor of a meter in position F_A will rotate in reverse direction when the piston is returned to its starting position.

Leakage of the four-way valve would mean that some fluid bypasses the prover but may still flow through the meter F_B . Therefore, the four-way valve is equipped with a continuously operating leak detection device. Leakage via the two piston seals, which has the same effect as leakage through the four-way valve, can be detected when the piston is in its starting position.

To check the uniformity of the velocity of the piston, an extra switch has been provided midway between the start and the stop switch. In the start position, with the four-way valve in the position as shown in the drawing and the starting valve opened, the piston will not move. When the flow is stable, the piston is set in motion by closing the starting valve. When the piston passes the switches a_2 , b_2 and c_2 , the respective pulse counts, time measurements and analogue measurements are started. When the piston reaches the switches a_4 , b_4 and c_4 , the respective counts and measurements are stopped. When the piston reaches the end of the cylinder, the check valve opens so that the flow is not interrupted. When the four-way valve is switched to the position indicated by the dotted line, the piston will return to its starting position.

Figure 2 gives a block diagram of the electronics attached to the piston prover. There are three blocks :

- control logic,
- a Data Recording System (D.R.S.),
- a computer.

In the D.R.S., the pulses are counted and times are measured. The corresponding gating of the counters and timers is taken care of by the control logic. The digital status signals are processed in the control logic and passed on to the computer via the D.R.S. The various analog signals are scanned by the D.R.S. When a proving run has been completed, the computer reads the measured quantities from the D.R.S. For each of the three measuring volumes an individual set of measured parameters is presented. Next, the calibration factor, the variation in the piston velocity and the flow rate are calculated. When the calibration procedure for one particular flow rate has been completed, the average meter factor and the corresponding standard deviation are determined for each measuring volume. From the complete set of measurements, an average meter factor value and the standard deviation of this average are determined.

Testing of the piston prover

The piston prover has been tested by DSM and by IJkwezen. The volumes corresponding to piston displacement between the different switches in the measuring section have been determined by :

- measuring the diameter and the length of the pipe sections concerned ;
- collecting the amount of water displaced when the piston moves from the start switch to the stop switch (water draw) ;
- using a volume flow meter calibrated with a prover tank at different flow rates (master meter method).

The results of the tests are summarized in Table 2

TABLE 2

Calibrated volume in dm ³						
DSM				IJkwezen		
Trajectory		Geometrical measurements	Water-draw	Water-draw	Master-meter method	
					30 m ³ /h	80 m ³ /h
a2	a4	147.35	147.395	147.41	147.40	147.42
b2	b4	147.36	147.392	147.41	147.39	147.41
c2	c4	147.38	147.391	147.42	147.40	147.42

The calibration certificate issued by the IJkwezen gives the following formula for the measuring volume :

$$V_{tp} = 147.41 + 0.007 (t - 20) + 0.0001 p \quad \text{dm}^3$$

where :

t = prover temperature in °C ;

p = gauge pressure in the prover, in bar.

All the values mentioned in the table, except one, do not differ by more than 0.03 % from the value stated in the certificate.

Traceability of high-pressure gas meter provers in the Netherlands

Figure 3 shows the traceability chain for test facilities with which high-pressure gas meters are calibrated. The basic verification system is a displacement system. Its operation is described in [2]. In this system oil flows from a tank and is replaced by air. The volume of the displaced oil is determined from its mass. The air replacing the oil is measured with one of the following metering devices in arbitrary order :

- a 0.5 m³ bell prover (a gas holder with a calibrated scale, which is used as a measuring instrument) ;
- a CVM-meter (a rotary meter with annular measuring chambers) ;
- a wet test meter (displacement per revolution = 50 dm³).

The meter factors of these three metering devices are determined at flow rates of 2, 4 and 6 m³/h. Intercomparison of these instruments has shown that the uncertainty in the meter factors is not more than 0.02 %.

The G40 CVM-meter, the wet test meter and three G40 CVM-meters being part of a transportable test unit are calibrated over their complete measuring range with the 0.5 m³ bell prover. From the results of many series of independent measurements at various flow rates, it could be calculated that the uncertainty in the meter factors of these meters is not more than 0.04 %.

The G40 CVM-meters of the transportable unit are used to determine the volume of a 4 m³ bell prover. The results are checked by measurements with the wet test meter and the G40 CVM-meter, which were calibrated with the same small bell prover as the three G40 CVM-meters of the transportable test unit. The uncertainty in the volume of the 4 m³ bell prover is 0.10 %.

The 4 m³ bell prover, which can be filled with natural gas, is used to calibrate three G250 CVM-meters being part of another transportable test unit. The calibration is carried out with natural gas under nearly atmospheric conditions. In the Gasunie laboratory the transportable unit is installed in series with a test facility having ten G250 CVM-meters in parallel. With each meter of the transportable installation the meter factor of each of the ten meters of the Gasunie installation is determined with gas under atmospheric conditions.

Next, the meter factors of the meters in the transportable unit are determined at a gauge pressure of 8 bar, as follows : after the gas has been measured with one meter under a gauge pressure of 8 bar, it is expanded to nearly atmospheric pressure and measured with a number of parallel-arranged meters of the fixed installation. During these measurements, the pressure in the last mentioned meters is nearly the same as during their calibration. From the volume measured under atmospheric conditions by the parallel-arranged meters, the volume at 8 bar gauge pressure is calculated. The compressibility factor required for this calculation is determined according to the modified version of AGA-NX 19 (AGA-NX 19 mod.) [3]. This determination of the meter factors of the meters of the transportable installation at 8 bar gauge pressure is repeated several times at the same flow rate and using different combinations of parallel-arranged meters of the fixed installation, to obtain independent series of measurements. Next, the meter factor at 8 bar of each of the ten CVM-meters of the fixed installation is determined with each meter of the transportable unit.

The uncertainty in the meter factors at 8 bar gauge pressure of the ten G250 CVM-meters at the Gasunie laboratory is 0.13 %. This « primary » high pressure test installation is almost exclusively used to calibrate reference meters of other high pressure test installations. The reference meters of the test facilities in Bergum and Utrecht, for example, are derived from the « primary » high-pressure gas meter test unit.

When reference meters are to be calibrated at pressures of more than 8 bar, the gas is expanded to 8 bar after it has passed the meter to be calibrated. Thus, the primary high-pressure test facility is used at the pressure at which it was calibrated.

Depending on the pressure at which a meter was calibrated in Groningen (maximum 40 bar), the uncertainty in the results obtained is 0.15-0.21 %.

The reference meters in Bergum have been calibrated at pressures of more than 40 bar by reducing these pressures to the pressures at which transfer standards were calibrated in Groningen. The reference meters of the Westerbork installation are derived from the Bergum installation. The uncertainty in the results obtained in a test in Westerbork is not more than 0.3 %.

Testing of the piston prover with gas

During calibration of the piston prover with water it was found that the pressure differential required to move the piston was small, nearly constant, while the piston was moving between the detector switches. On the assumption that with high pressure gas the prover behaves similarly, it was decided to do a number of tests with gas. The prover was connected with the Gasunie « primary » high pressure test unit together with a gas meter that was to be calibrated (see Figure 4).

In this set-up, the gas flowed through the piston prover and through the meter to be calibrated (F) at a pressure of 35 bar and then, after pressure reduction to 8 bar, through one CVM-meter or a number of parallel-arranged CVM-meters of the « primary » high pressure test facility. To prevent large temperature differences, in each point of the set-up the gas was kept as well as possible at ambient temperature, which required the use of a heat exchanger (HE). The test consisted in calibration of the meter with, alternately, the piston prover and the CVM-meters. For each gas flow rate, the meter was calibrated three times with the CVM-meters used as a reference, and 4 to 8 times with the piston prover.

The calibrations were performed on two meters: a 4" turbine meter and a 3" CVM-meter, both rated G250. The temperatures used in the calculation of the gas volume were measured with Pt 100 resistance thermometers. The gas pressure in the meter to be calibrated was measured with a pressure transmitter. The pressure in the piston prover was determined by measuring the pressure difference between the piston prover and the meter under test with a differential pressure transmitter.

The static pressure in the CVM-installation was measured with a dead weight tester, which was also used to calibrate the pressure transmitter mentioned above.

The compressibility of the gas was calculated according to the AGA-NX 19 mod. method. After the tests in Groningen, the piston prover was taken to the Bernoulli laboratory in Westerbork, where tests were carried out with the CVM-meter at a pressure of about 60 bar. In Westerbork, the meter was calibrated with the piston prover only, since the flow rate through the test set-up was very low relative to the capacity of the reference meters installed there. All instruments used were calibrated prior to the test. Since the piston prover was available for testing for only a limited period, measurements were done at only two pressures, 35 and 60 bar, and at six flow rates.

Results

The results are pictured in Figs. 5 and 6. The horizontal axis represents the flow rate in m^3/h , the vertical one represents the meter factor expressed as the number of pulses counted per m^3 of gas passed through the meter.

The graphs show the following curves:

- the calibration at 35 bar with the piston prover;
- the calibration at 35 bar with the CVM installation;
- the calibration at 60 bar with the piston prover (only the CVM meter).

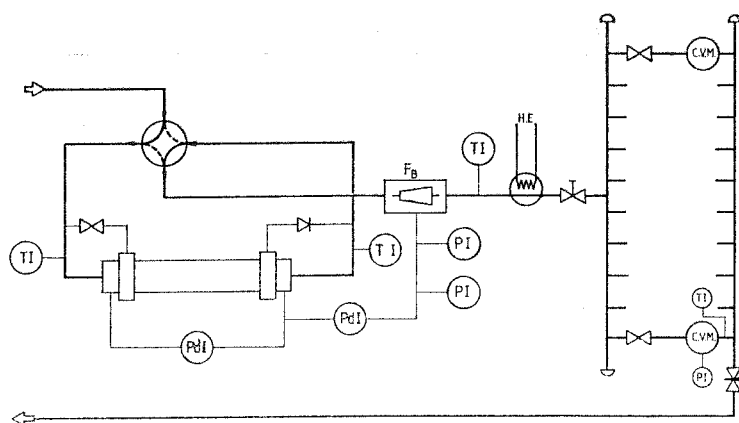


Fig. 4
Installation at Groningen
at the time of the prover test

FB meter to be calibrated
TI temperature measuring instrument
PI pressure measuring instrument
PdI differential pressure measuring instrument
HE heat exchanger
CVM constant volume meter

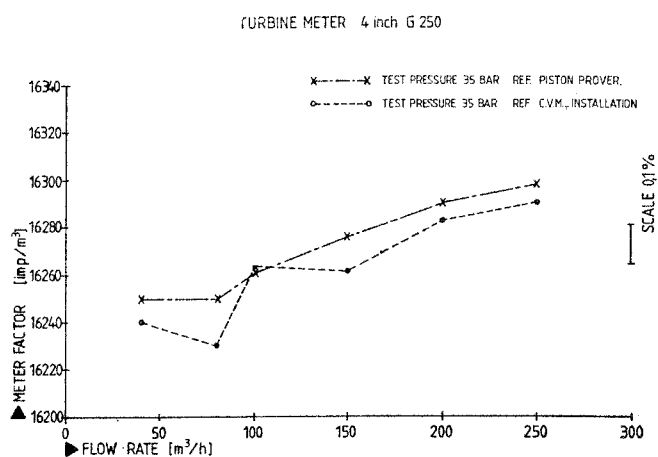


Fig. 5 — Calibrations of a turbine meter by using the piston prover and the CVM installation at a pressure of 35 bar

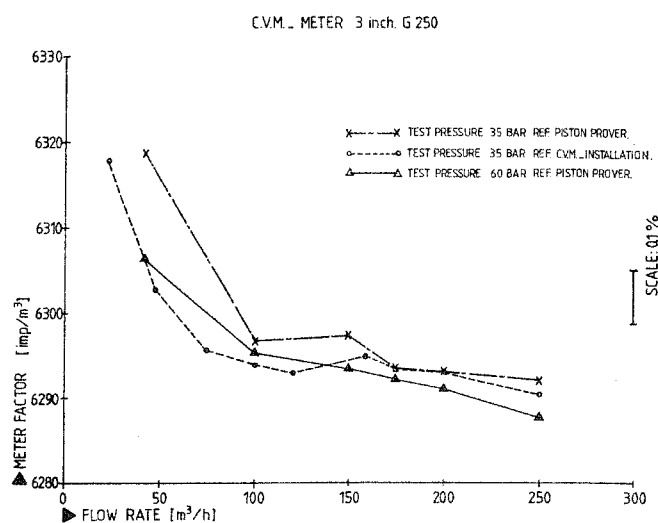


Fig. 6 — Calibrations of a CVM meter using the piston prover and the CVM installation at a pressure of 35 bar.

Separate calibration of the same CVM meter using only the piston prover at 60 bar

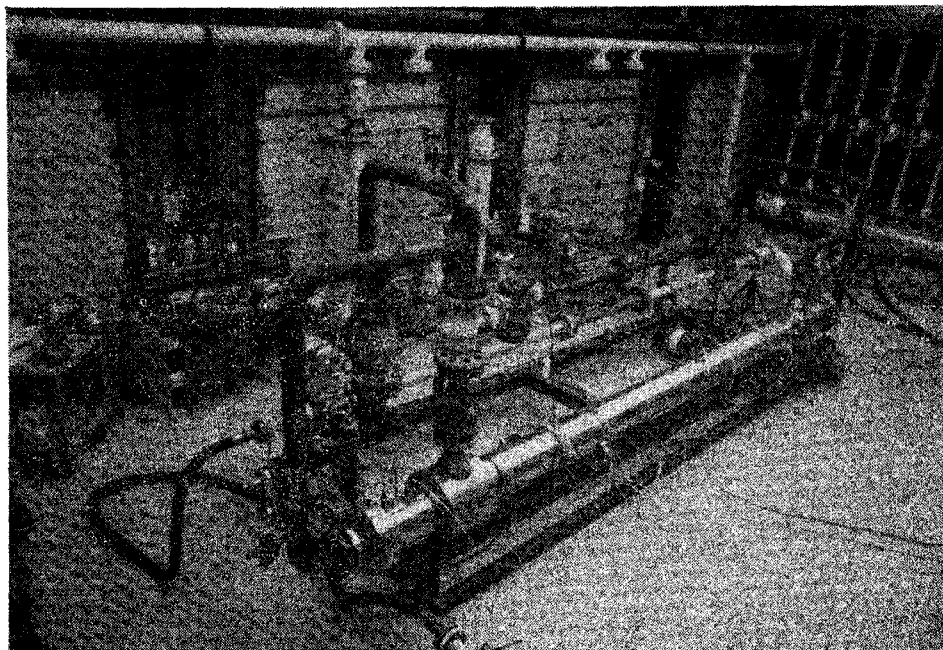


Fig. 7

Piston prover in the high pressure calibration set-up of Gasunie Research Laboratory

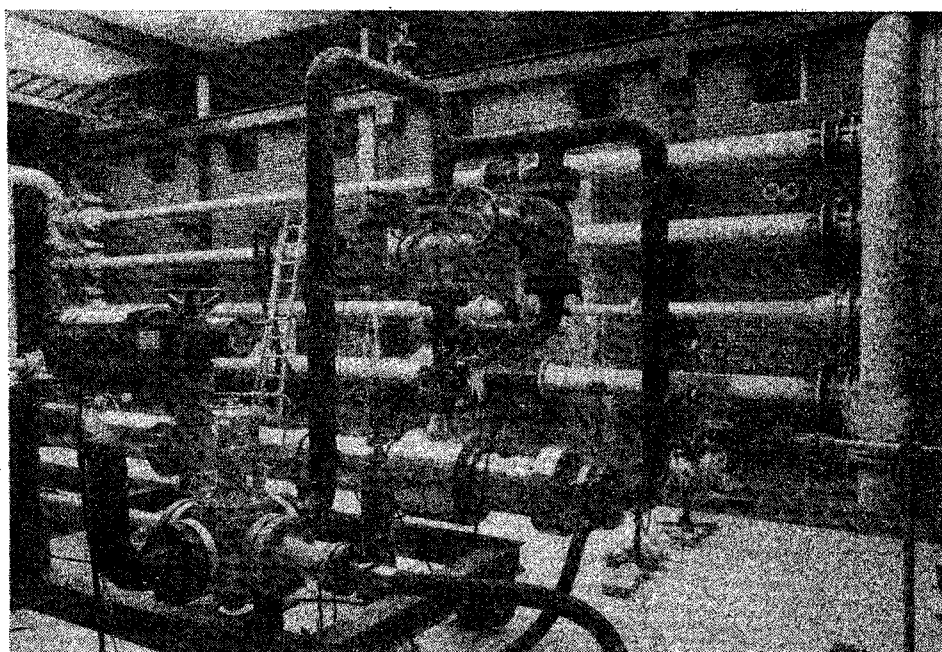


Fig. 8

Detail of the piston prover with four-way valve, bypass with starting valve and back pressure valve

The first two curves can be directly compared, because they were obtained with the same installation and under the same pressure.

Taking into account the properties of a CVM-meter, the curve obtained at 60 bar is completely according to expectation. Except the result obtained at about 40 m³/h with the CVM meter, the differences between the results obtained with the piston prover and those results obtained with the « primary » high-pressure gas meter test installation are less than 0.1 %. The standard deviation during the measurements was less than 0.05 %.

Conclusions

1. There is very good agreement between the results obtained with the piston prover and those obtained in calibrations with the « primary » high pressure test installation. This means that for natural gas at 8 bar the uncertainty in the meter factors of the primary high pressure test installation definitely does not exceed 0.13 % as indicated in Fig. 3.

2. During tests on the G250 CVM-meter and the G250 turbine meter at 35 bar with the « primary » high-pressure test installation, the volume of gas passed through the meters was calculated from the volume measured at 8 bar with the primary high-pressure test installation. The standard AGA-NX 19 mod. was used for determination of the compressibility factor. Weighings of a known volume of Slochteren gas, some years ago, showed that the uncertainty in the compressibility factor calculated with AGA-NX 19 mod. is smaller than assumed in the beginning. This is confirmed by the present results.

3. Although the piston prover was available for tests with natural gas for only a limited period, the results show that a piston prover can be a useful instrument for calibration of gas meters under high pressure. There is no need to calibrate all high pressure gas meters with piston provers, but when a piston prover is used to calibrate standard high pressure reference meters, the laborious and time-consuming procedure of tracing these references to atmospheric conditions can be dispensed with.

These conclusions are based on tests with one piston prover, the ARG-prover. Further research is needed to explore potential applications of piston provers in gas meter testing.

References

- [1] van Laak F.A.L., Developments in the field of prover loop for the calibration of flowmeters. Journal A, (Netherlands/Belgium), volume 24, no. 1, 1984.
- [2] HOEKS, C.P., Legal aspects and traceability of high-pressure gas measurements in The Netherlands. In DIJSTELBERGEN, H.H. and SPENCER, E.A. (Eds.) Flow measurement of fluids, Proc. FLOMEKO 1978. Amsterdam : North Holland Publishing Company, 1978.
- [3] Herning F., Wolowski E., Kompressibilitätszahlen und Realgasfaktoren von Erdgasen nach neuen amerikanischen Berechnungsmethoden. Ges. Ber. Ruhrgas 15 (1966) S.7-14.

SUEDE

MOBILE MASS COMPARATOR for HEAVY WEIGHTS *

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SUMMARY — For the calibration and adjustment of heavy test weights on their site of use the Swedish metrology service uses since 5 years a transportable comparator comprising a suspended strain-gauge load cell. The influence of creep is reduced by taking the measurements at a given lapse of time after the lifting of the load. The uncertainty reached by this device is lower than 10 g when making substitution weighing of 500 kg weights.

RESUME — Pour l'étalonnage de fortes masses de vérification sur leur lieu d'utilisation, le service de métrologie suédois utilise depuis 5 ans un comparateur transportable utilisant un capteur de force à jauges de contrainte. L'influence de l'effet de fluage du capteur est réduite en effectuant toujours la mesure à un intervalle de temps donné après le soulèvement de la charge. L'incertitude obtenue à l'aide de ce dispositif est inférieure à 10 g lors des comparaisons par substitution des masses de 500 kg.

Background

In the verification and calibration of weighbridges in Sweden we usually use standard weights to full capacity. As Sweden is a long country (about 1 650 km) and we have many truck scales with a capacity of 60-80 tonnes, there is a need for a large number of test weights. We thus have 1 200 tonnes of 500 kg weights and 200 tonnes of 1 000 kg weights stored in 40 different places. These are regularly calibrated every two years. Transport of the weights over long distances is expensive. Earlier, several equal-armed balances were used but they needed much maintenance and took a long time to use. Over the last 5 years we have used a recently developed portable weight calibrator and this year we have started to use a second generation version.

Requirements

The requirements we had on the weight calibrator was that it should be able to be towed by a personal car and have the resolution and uncertainty indicated below.

Nominal load kg	Resolution g	Uncertainty g
50	0.1	± 2
100	0.2	3
500	1	10
1 000	2	20

In this case we defined the uncertainty as the difference between measurements on the standard weight before and after measurement on 10 unknown weights.

* Paper presented at the OIML Seminar on Testing of Bulk Weighing Installations, Paris 22-25 April 1985.

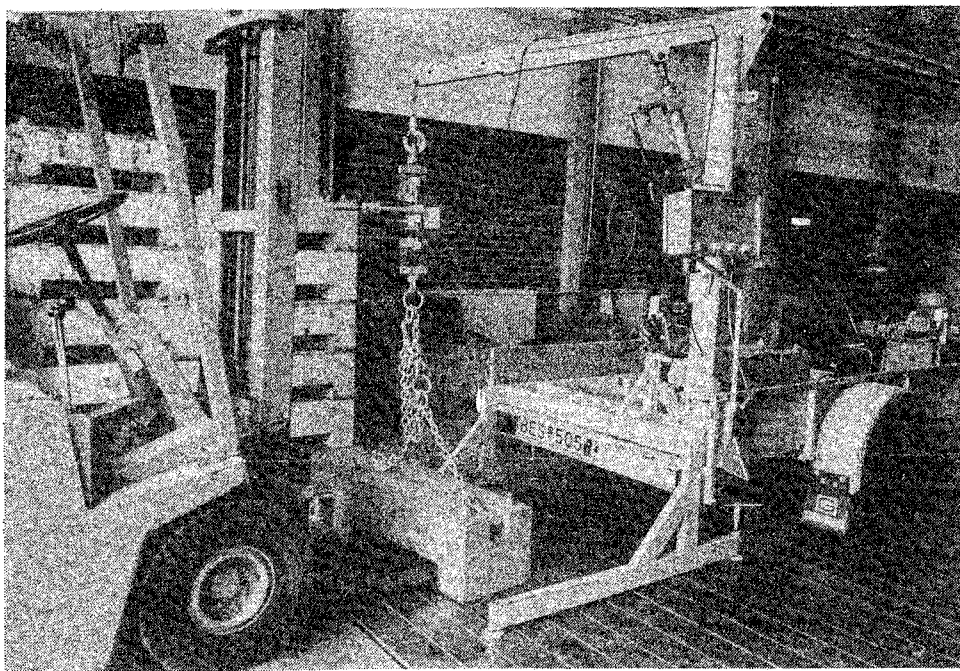


Fig. 1 — Weight calibrator using a suspended load cell and the hydraulic lifting device mounted on the trailer to the right. The test weights are moved using the fork lift to the left.

Realization

The weight calibrator, built on a car trailer, was developed by the Swedish Testing Institute in cooperation with a firm specialized in electronic instrumentation (Erde Elektronik).

It consists of an hydraulic lifting device (Fig. 1), a standard load cell made by Bofors Elektronik (Fig. 2), a microprocessor controlled indicator (Fig. 3) and the standard test weights.

Three different load cells are used with the following capacities 1 000, 500 and 100 kg. It was in practice found that a very high resolution (1 part in 10^6) could be attained especially for the 100 kg load cell which is used for calibrating both 100 and 50 kg weights. Such resolutions can usually only be reached by special laboratory balances.

However, by using a special measuring method it is possible to obtain this resolution also in an industrial mobile weight calibrator. To reach these results we identified the following factors that affect the accuracy.

1. Temperature effect on zero
2. Temperature effect on sensitivity
3. Non-repeatability
4. Non-linearity
5. Creep
6. Noise

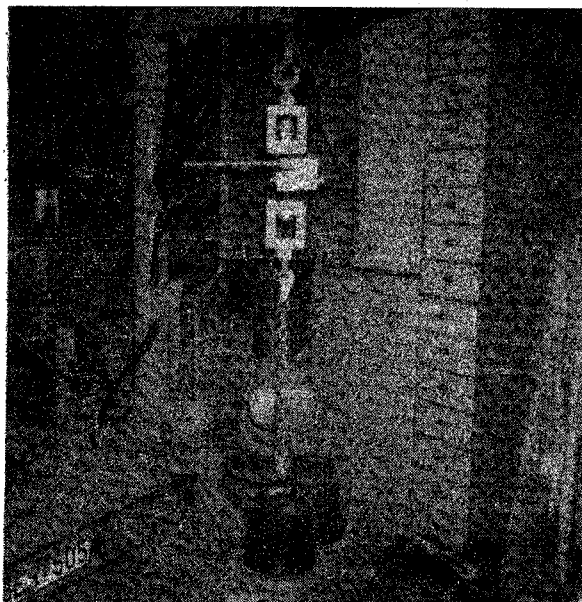


Fig. 2 — The load cell and its equilibrated suspension devices.

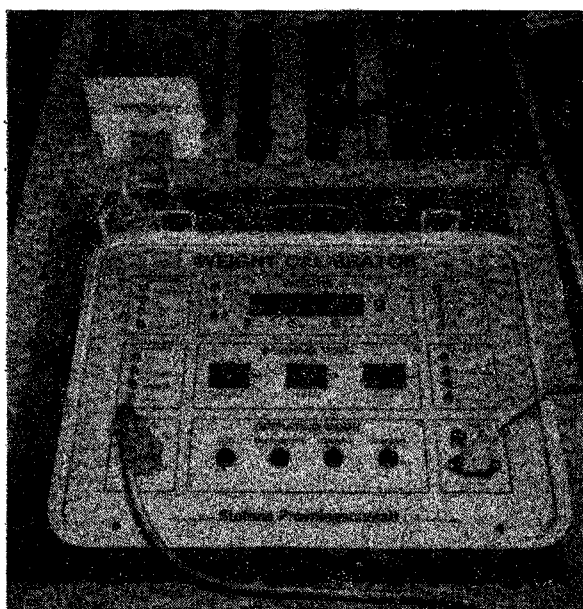


Fig. 3 — The new version of the micro-processor controlled indicator.

The factors are dealt with in following ways :

1. Temperature effect on zero

Since the loadcell will be affected the whole time by either the load or by the lifting equipment, it is not possible measure the zero output from the load-cell between the measuring moments. Therefore the loadcell must have a very low thermal zero drift. The loadcells used are however, standard industrial loadcells, but have been carefully selected from the manufacturers production.

The temperature effect on the offset of the input amplifier can be compensated and eliminated since the amplifier is not used between the measuring moments, and therefore can be used during this time to measure its offset value. This value is used both to compensate the thermal zero drift and to calculate the maximum interval between the calibration moments.

To minimize all temperature effects the temperature in the room should be stable, with no direct sunshine on the loadcell and both the loadcell and the instrument should have been stored at room temperature for a sufficient time so that all components have reached the same temperature. The loadcell is very massive and therefore temperature equilisation could take a considerably long time if the loadcell has been stored at a very different temperature before. Power should also have been applied to the instrument and loadcell for at least 15 min to allow for warm up.

2. Temperature effect on sensitivity

As in the case of the temperature effect on zero, there is no way to measure and compensate for the thermal drift in sensitivity of the loadcell. A loadcell with a sensitivity which has a very low thermal dependence must thus be used.

The sensitivity will also be affected by changes in the loadcell excitation, amplifier gain and the gain of the A/D-converter. These factors are almost eliminated by an analog compensation using high accuracy resistors at the output from the loadcell. With load applied, the output from the loadcell will in this way be almost zero. The measured difference from zero is amplified and used as the measuring value. The total span of this « WINDOW » is about 4 % of the total span. Therefore the temperature effect will be minimized 25 times by this measuring method.

Each time a new calibration with a known weight is made, the difference between the two calibration values is calculated. From this value the longest permitted interval between calibrations is calculated and displayed. The interval employed is also displayed to help the operator.

3. Repeatability

The loadcell (Fig. 3) must have an extremely good repeatability and the lifting equipment must apply the load in exactly the same way each time, without dangerous overloading. This is one of the most important factors.

The electronic circuits have extremely good repeatability and will not effect the measurements.

4. Non-linearity

The measuring method using substitution with known weights, analog output compensation and the 4 % window, will eliminate all major errors from non-linearity.

5. Creep

This is a very difficult factor to take into consideration. When the load has been applied and the output has reached its correct value corresponding to the load, the output value will still increase during a very long period of time due to creep,

first very rapidly but then more slowly. To wait until the creep is so low that one could say that the output is stable, would take much too long time. Since a very high resolution is needed and the whole loadcell range is used, practical tests have shown that this could take more than 15 minutes.

The effect of creep is minimized to an acceptable level by sampling the output value after a fixed time for every measurement. Practical tests have shown that the optimum time is about 30-40 seconds.

It is also very important that the loadcell is unloaded for at least the same period of time as the load has been applied. To help the operator, the time before loading is displayed and should reach zero before the load is applied again.

6. Noise

The noise in the output of the loadcell comes for example from vibrations of the hydraulic pump, electrical noise and other similar effects. These have a rather high frequency, at least more than 1 Hz, and will have no effect on the measuring value, since the instrument calculates the mean value over a period of 20 seconds.

Low frequency noise is more difficult to eliminate. The worst error comes from an oscillatory motion of the load and loadcell. This must not occur and the operator must be very careful when he lifts the load since there is no other way to detect and compensate for this low frequency and non-reproducible noise.

Practical use

It is of course very important that the operator of this mobile unit is very careful when he handles the weights and when he lifts the weights with the hydraulic lifting equipment. A careless handling with the weights will create measuring errors which make the equipment useless.

The first generation of the weight calibrator instrument has been in operation together with a 500 kg loadcell for about 5 years with very good results. This prototype has shown that it is possible to use such a high resolution mobile equipment in practical calibration work.

Typical results of the new weight calibrator are given below

Load kg	Standard deviation	
	in g	in relative value
50	0.4	$8 \cdot 10^{-6}$
100	0.7	7
500	3	6
1 000	16	16

Though the relative standard deviation is noticeably higher for the 1 000 kg load it is still sufficient for current work even at this high load.

Conclusion

The practical use of the weight calibrator showed that we have achieved our aim in developing a fast and easy method of calibrating heavy test weights. It is thus now possible to calibrate in two days a weight set of 60 tonnes consisting of 120 weights of 500 kg.

LITTERATURE

Vocabulaires et dictionnaires

Chinois — Le Vocabulaire de Métrologie Légale (VML) a été traduit en chinois et existe en deux éditions, l'édition complète comprend également le texte original en français et en anglais.

Le Vocabulaire International des termes fondamentaux et généraux de métrologie (VIM) a aussi été traduit en chinois.

Japonais — Le BIML a reçu dernièrement un dictionnaire d'instrumentation japonais-anglais qui a l'avantage de reproduire aussi les termes japonais en caractère romains : Japanese Scientific Terms Instrumentation Technology, published by the Society of Instrument and Control Engineers, 1973.

Croate — Le Vocabulaire International de Métrologie (VIM) avec équivalences en français et en anglais a été publié en langue croate par l'Association de Métrologie Croate : Mjeriteljsko drustvo Hrvatske, Berislaviceva 6, 41000 ZAGREB, Yougoslavie.

Répertoire ILAC

La troisième édition du Répertoire International des Organisations d'Essais et de Systèmes d'Agrément de Laboratoires d'Essais vient d'être publiée par l'ISO et peut être obtenue auprès des organismes nationaux de normalisation.

Ce répertoire donne pays par pays le type d'activité, la structure administrative et l'adresse de 176 organisations nationales et associations privées engagées dans des opérations d'essais de matériaux, de la métrologie, de la santé, etc. ainsi que des indications sur les accords régionaux ou bilatéraux existants dans le cadre de ces organisations.

Publications USA

La brochure sur la vérification du contenu net des produits préemballés, intitulée, « Checking the net content of packaged goods », NBS Handbook 133, vient d'être entièrement révisée et publiée en tant que « Second edition, October 1984 ».

Un index de tous les rapports présentés aux conférences nationales de poids et mesures de 1905 à 1984 a été publié en tant que NBS Special Publication 691 « Index to the Reports of the National Conference on Weights and Measures ».

Dans la brochure « A Primer for Mass Metrology » par K.B. Jaeger et R.S. Davis, NBS-Special Publication 700-1, les auteurs traitent avec beaucoup de détails l'étalonnage de séries de poids et, en particulier, les corrections de la poussée de l'air.

Le BIML a reçu copie du premier module de formation produit par le National Conference on Weights and Measures, USA, qui a pour titre : Module N° 27 — Introduction to Electronic Weighing and Measuring Systems. Ce module contient des explications de base pour des inspecteurs de poids et mesures, sur le fonctionnement des machines de pesage électroniques et sur la terminologie couramment utilisée. Le module est en deux parties : un manuel illustré pour l'inspecteur et un manuel comportant 33 dispositifs pour l'instructeur. Les deux parties peuvent être achetées auprès de NCWM, P.O. Box 3137, Gaithersburg, Maryland 20878, USA.

Pesage

Le « Lexique du pesage — un guide pratique des termes relatifs au pesage » par L. Bietry et M. Kochsiek, édité par la maison Mettler, Greifensee, Suisse, existe maintenant dans les versions suivantes : allemande, anglaise, française et bientôt chinoise.

Nous sommes heureux également d'annoncer la parution d'un ouvrage sur le pesage, édité sous la direction de M. Kochsiek et intitulé

Handbuch des Wägens

publié par Fr. Vieweg & Sohn, Braunschweig, 1985

L'ouvrage comporte 661 pages, 492 figures et 21 tableaux. Les auteurs des différents chapitres sont pour la plupart des collaborateurs bien connus des cercles de l'OIML. Ainsi W. Trapp donne un aperçu historique de l'évolution des instruments de pesage, K.H. Ach, R. Balhorn et M. Kochsiek décrivent les bases des mesures de masse et K. Horn les principes des différents capteurs. La classification et la construction des instruments font l'objet d'un chapitre par K. Weinberg. L'exécution technique des différents types de balances est traitée en détail par un grand nombre de spécialistes. Le livre comporte également des chapitres sur la réglementation et l'approbation de modèle par M. Kochsiek, sur les dispositifs d'enregistrement des données par F. Sandhack et H.J. Sacht sur les facteurs d'influence par K. Wiedemann et sur la fiabilité par Ch. U. Volkmann. Une annexe comporte des articles sur l'évolution historique de la balance de précision par H.R. Jeneman, sur les services de métrologie en R.F.A. par E. Seiler, sur les associations de constructeurs par H. Kraushaar. L'ouvrage est complété par des tableaux (correction de g et densité de l'air) ainsi que par des adresses utiles.

M. Kochsiek nous a informé qu'il envisage la possibilité d'une édition anglaise comportant une sélection des chapitres de cet excellent livre complétée par des chapitres relatifs aux dispositifs électroniques.

Nous signalons également que la PTB organise souvent des séminaires de métrologie en langue allemande. Les exposés du 54ème et du 57ème séminaires tenus au début 1984 concernant la détermination de masse avec grande exactitude ont été réunis dans un rapport intitulé

Massebestimmung hoher Genauigkeit
édité sous la direction de M. Kochsiek
PTB-Bericht PTB-Me 60, Juni 1984

Manuel roumain d'instrumentation

Un grand nombre de livres de métrologie et instrumentation s'adressant en particulier aux techniciens de l'industrie sont publiés en Roumanie.

Le BIML a reçu de M. George Slapciu un exemplaire d'un ouvrage collectif « Cartea operatorului si lucratorului de intretinere de la panourile si tablourile de comanda echipate cu mijloace de masurare si automatizare, Editura Technica, Bucarest, 1984 », ce qui en abrégé, veut dire « manuel de l'opérateur et du technicien de maintenance des tableaux de contrôle et d'automation ».

Le livre comprend des chapitres, par Serban Buruda, sur la métrologie légale, les mesures de pression, débit, niveau et vitesse de rotation ; par Gabriel Iordachescu sur la métrologie générale et les mesures de température ; par Florica Oprea sur les mesures physico-chimiques ; par Doina Boboc sur les mesures électriques et par George Slapciu sur l'automation et la régulation.

Compte tenu de la rareté des livres de métrologie qui sont encore disponibles dans le commerce, on peut encore une fois regretter que le Roumain ne soit pas une langue facilement compréhensible dans les autres pays.

Bibliographie, Pologne

Une brochure comportant une liste complète des publications des Collaborateurs du Service Polonais de Métrologie pour la période 1945-1983 a été publiée à l'occasion du 65ème anniversaire de cet organisme.

L'auteur est M. Jerzy Mikoszewski et le titre « Zestawienie Publikacji z lat 1945-1983 pracownikow Polskiej Sluzby Miar ».

International Federation of Clinical Chemistry

L'ensemble des Recommandations de la Fédération Internationale de Chimie Clinique vient d'être publié en anglais sous forme d'un livre :

IFCC Recommendations and Related Documents, Volume 1, 1978-1983, Editor Nils-Erik Saris, publié par Walter de Gruyter & Co, Berlin 30.

En ce qui concerne la métrologie, on peut remarquer en particulier les chapitres sur les Unités et Grandeurs, Contrôle qualité (étalonnages), Instrumentation, pH dans le sang (matériaux de référence), etc.

On note également les efforts de l'IFCC pour utiliser une terminologie et des définitions précises. Ce livre a sans aucun doute sa place dans la documentation de tous les services de métrologie s'occupant de mesures dans le domaine de la santé.

Pollution et analyses physico-chimiques

Un grand nombre de brochures (plus de 87) sur les différentes méthodes d'analyse de l'eau ont été éditées depuis 1976 par le Standing Committee of Analysts, Department of Environment, Royaume-Uni et sont publiées par Her Majesty's Stationary Office.

Parmi les dernières brochures parues on peut en noter une qui concerne l'utilisation des sources radioactives pour la détection de niveau, mesures de densité, analyse par activation, mesures de débit, etc :

Four Essay Reviews on Applications of Radiation Measurement in the Water Industry, 1984.

Ces brochures décrivent d'une façon claire les principes de méthodes instrumentales avec des références bibliographiques souvent importantes. Certaines brochures sont de ce fait très utiles, pas seulement pour ceux qui s'occupent de l'analyse de l'eau, mais également pour l'enseignement en général des méthodes instrumentales d'analyse.

Dans ce contexte, nous citons par exemple les brochures suivantes :

- The Measurement of Electrical Conductivity and the Laboratory Determination of the pH Value of Natural, Treated and Waste Waters, 1978,
- Atomic Absorption Spectrophotometry, An Essay Review, 1979,
- Emission Spectrophotometric Multi-element Methods of Analysis for Waters, Sediments and Other Materials of Interest to the Water Industry, 1980,
- Gas Chromatography — an Essay Review, 1982,
- High Performance Liquid Chromatography, Ion Chromatography, Thin Layer and Column Chromatography of Water Samples, 1983.

ASMO

Le BIML a reçu de l'Organisation Arabe de Normalisation et de Métrologie, une brochure en Anglais qui définit les objectifs et donne une liste des comités techniques et les buts atteints jusqu'ici par l'Organisation :

« Establishment, Objectives, Technical Committees and Achievements », ASMO, P.O. Box 926161, Amman, Jordan.

ASMO organise fréquemment des symposiums et des cours de métrologie (en 1980, 1981, 1982 et fin 1985) dont les exposés sont publiés.

De plus, un guide sur la surveillance métrologique a été publié en 1982 (Weights and Measures Inspection Guide) et un certain nombre de Recommandations de l'OIML ainsi que le Vocabulaire de Métrologie Légale ont été traduits en arabe.

Etalons et Unités

Une brochure (30 pages) avec ce titre a été publiée en décembre 1984 par le Bureau National de Métrologie, 8-10, rue Crillon, 75194 Paris Cedex 04.

Ce document réalisé par le Secrétariat du BNM en coopération avec sa Commission scientifique et les laboratoires de métrologie français constitue un outil très valable pour l'enseignement des unités SI et leur réalisation scientifique et pratique.

Publications du NPL, Royaume-Uni

Plusieurs brochures décrivant les activités des différents départements du National Physical Laboratory à Teddington ont été publiées en 1984 :

- NPL — A report on current work,
- NPL — Customer services
- NPL — Annual Report

On remarque également une nouvelle présentation de la revue « NPL news » qui contient des articles de vulgarisation basés sur les travaux du NPL.

Métrologie dans les Pays en Développement

Le Japon organise régulièrement, sur invitation, des cours ou des symposiums pour des pays en développement. Le troisième symposium de ce type a eu lieu du 17 au 21 septembre 1984.

Les exposés sont contenus dans

« Proceedings of the 3rd International Symposium on Metrology and Measurement Standards in Developing Countries — ISMET 84 » publié par Office of International Relations, National Research Laboratory of Metrology.

En plus des rapports sur l'organisation de la métrologie dans les pays participants (Indonésie, Philippines, Thaïlande, Corée, Malaisie, Singapour, Chine, Inde, Brésil et Japon) le volume contient également des articles sur Electronique et Métrologie Légale (Pays-Bas) sur la Vérification des produits préemballés au Japon, sur un Gravimètre absolu transportable (Chine) et un exposé d'introduction sur les activités de l'OIML par M. Petik.

Des cours régionaux pour pays en développement sont également organisés par Korea Standards Institute (KSI). Le deuxième a eu lieu du 16 au 29 octobre 1984 avec 14 participants des pays suivants : Bangladesh, Indonésie, Malaisie, Pakistan, Singapour, Sri Lanka et Thaïlande. Les excellents laboratoires et le savoir du KSI ainsi que les méthodes d'étalement dans différents domaines de la métrologie furent l'objet d'exposés qui ont été imprimés en deux volumes avec le titre

« Workshop on National Calibration System
and Precision Measurement Technology ».

Les exposés présentés au séminaire organisé par le Commonwealth Science Council, l'UNESCO et le NPL, Inde avec la participation du BIML, du 6 au 17 février 1984, ont maintenant été imprimés en deux volumes en tant que CSC-Publication Series N° 158 CSC(85) ISP-4 et peuvent être obtenus auprès du Commonwealth Secretariat, Marlborough House, Pall Mall, London SW1Y 5HX.

Finalement nous signalons que les exposés du séminaire « Regional Workshop for Developing Countries » tenu à Sydney en septembre 1982 sont maintenant disponibles sous forme d'un livre qui a pour titre

P.L. Hewitt (ed.) : Modern Techniques in Metrology
publ. by Singapore World Scientific (distr. John Wiley, 1984).

Métrologie historique

La représentation iconographique de la balance a fait l'objet d'une thèse présentée à l'Université de Paris 1 :

La balance, historique et iconographie du XIème au XVème siècle. Volume I (texte), 118 p., Volume 2 (planches), 195 p., septembre 1984.

Cet ouvrage ronéotypé présente surtout un grand intérêt en ce qui concerne les planches et les descriptions qui les accompagnent.

Il est possible d'acheter des exemplaires en s'adressant à l'auteur : Mlle Christiane CHABALLIAN, 134, rue du Bac, 75007 PARIS.

Index du Bulletin de l'OIML

A l'occasion de la parution du N° 100 du Bulletin, nous publions comme supplément à ce numéro un Index à tous les articles parus depuis la création du Bulletin en 1960.

LITERATURE

Vocabularies and dictionaries

Chinese — The Vocabulary of Legal Metrology (VML) has been translated into Chinese. There are two versions of this vocabulary, the complete version includes also the original French and English texts.

The International Vocabulary of Metrology (VIM) has also been translated into Chinese.

Japanese — The BIML has recently received a Japanese-English instrumentation dictionary which has the advantage of including the Japanese terms in Roman characters : Japanese Scientific Terms Instrumentation Dictionary published by the Society of Instrument and Control Engineers, Japan, 1973.

Croat — The International Vocabulary of Metrology (VIM) with French and English equivalent terms has been published in the Croat language by the Croat Metrology Association : Mjeriteljsko drustvo Hrvatske, Berislaviceva 6, 41000 ZAGREB, Yugoslavia.

ILAC Directory

The third edition of the ILAC International Directory of Laboratory Accreditation Systems has recently been published by ISO and can be obtained through the national standards organisations.

This directory lists country by country the administrative structures and the addresses of 176 national organisations and private associations engaged in schemes of testing of materials, metrology, analysis within the field of health, etc. and gives indications concerning the existence of regional or bilateral agreements.

USA publications

The book « Checking of the net content of packaged goods » NBS Handbook 133 has been completely revised in its Second edition, 1984.

An index of all the reports presented at National Conferences on Weights and Measures from 1905 to 1984 has been published as NBS Publication 691.

The calibration of sets of weights taking into account air density corrections is treated with great detail in « A Primer for Mass Metrology » by K.B. Jaeger and R.S. Davis, NBS-Special Publication 700-1.

The BIML has received copy of the first training module produced by the U.S. National Conference on Weights and Measures : Module No. 27 — Introduction to Electronic Weighing and Measuring Systems. This module contains explanations for weights and measures inspectors on the basic structure of electronic weighing machines and the terminology currently used. The module consists of two parts : an illustrated inspector's manual and an instructor's manual, the latter containing 33 slides. Both can be purchased from NCWM, P.O. Box 3137, Gaithersburg, Maryland 20878, USA.

Weighing

The « Dictionary of Weighing Terms — A practical guide to the Terminology of Weighing » by L. Bietry and M. Kochsiek edited by the Mettler company, Greifensee, Switzerland now exists in the following languages : German, English, French and soon Chinese.

We are also happy to announce the publication of a new book on weighing edited under the direction of M. Kochsiek :

Handbuch des Wägens
publisher Fr. Vieweg & Sohn, Braunschweig, 1985

The book has 661 pages, 492 illustrations and 21 tables. The authors of the different chapters are generally well known within OIML circles. W. Trapp gives an historical account of the development of weighing machines, K.H. Ach, R. Balhorn and M. Kochsiek treat the foundations of mass measurements and K. Horn the principles of various weigh cells. The classification and construction of instruments are discussed in a chapter by K. Weinberg. The technical execution of the various types of weighing machines is treated in detail by a number of specialists. The book also contains chapters on regulations and pattern approval by M. Kochsiek, on data recording by F. Sandhack and H.J. Sacht on influence factors by K. Wiedemann and on measurement reliability by Ch. U. Volkmann. The annex contains papers on the historical evolution of the precision balance by H.R. Jenemann, on the metrology services of FRG by E. Seiler, on weighing manufacturers associations by H. Kraushaar. The book ends with tables concerning g and air density corrections and a list of useful addresses.

Dr Kochsiek has informed us that he thinks about the possibility of publishing an English edition comprising a selection of chapters of this excellent book together with new additions concerning electronic weighing devices.

We also remind our readers that PTB frequently organises metrology seminars in German. The presentations of the 54th and 57th seminars held in the beginning of 1984 concerning high accuracy mass measurements have been published in a report :

Massebestimmung hoher Genauigkeit
editor M. Kochsiek
PTB-Bericht PTB-Me 60, Juni 1984

Romanian instrumentation text-book

A great number of books on metrology and instrumentation intended in particular for industry technicians are published in Romania. The BIML has received from Mr George Slapciu a copy of a book « Cartea operatorului si lucratorului de intretinere de la panourile si tablourile de comanda echipate cu mijloace de masurare si automatizare, Editura Technica, Bucarest, 1984 » which in brief means « manual for the operator and maintenance technician of automation and control panels ».

It contains chapters by Serban Buruda on legal metrology, measurement of pressure, flow, level and speed of rotation ; by Gabriel Iordachescu on general metrology and temperature measurements ; by Florica Oprea on physico-chemical measurements, by Doina Bohoc on electrical measurements and by George Slapciu on automation and process control.

Taking into account the fact that commercially available metrology books are rare one may once more regret that the Romanian language is not easily understood in other countries.

Bibliography - Poland

A brochure containing a complete list of publications from 1945-1983 by the collaborators of the Polish Metrology Service has been published at the occasion of its 65th anniversary. The author is Jerzy Mikoszewski and the title « Zestawienie Publikacji z lat 1945-1983 pracownikow Polskiej Sluzby Miar ».

International Federation of Clinical Chemistry

All the Recommendations of the International Federation of Clinical Chemistry have been collected in the form of a book :

IFCC Recommendations and Related Documents, Volume 1, 1978-1983, Editor Nils-Erik Saris, published by Walter de Gruyter & Co., Berlin 30.

As regards metrology one notes in particular the chapters on Units and Quantities, Quality Control (calibration), Instrumentation, pH in blood (reference materials), etc.

One may also note the efforts by IFCC to use a well defined terminology. This book therefore no doubt has its place in the documentation of those metrology services which deal with measurements in the field of health.

Pollution and physico-chemical analysis

A great number of brochures (more than 87) on various analysis methods of water has been published since 1976 by the Standing Committee of Analysts, Department of the Environment, U.K. and are available from Her Majesty's Stationary Office.

Among the most recently published brochures one may note one which concerns the use of radioactive substances for level detection, density measurements, activation analysis, flow measurements, etc :

Four Essay Reviews on Applications of Radiation Measurement in the Water Industry, 1984.

These brochures describe very clearly the principles of the instrumental methods along with frequently extensive bibliographic references. Some of these brochures are therefore very useful not only for water analysts but also for general training in instrumental methods of analysis.

In this context we list as examples the following brochures :

- The Measurement of Electrical Conductivity and the Laboratory Determination of the pH value of Natural, Treated and Waste Waters, 1978,
- Atomic Absorption Spectrophotometry, An Essay Review, 1979,
- Emission Spectrophotometric Multi-element Methods of Analysis for Waters, Sediments and Other Materials of Interest to the Water Industry, 1980,
- Gas Chromatography — an Essay Review, 1982,
- High Performance Liquid Chromatography, Ion Chromatography, Thin Layer and Column Chromatography of Water Samples, 1983.

ASMO

The BIML has received from the Arab Standardization and Metrology Organization a brochure which defines its objectives, lists its technical committees and the goals reached by the Organisation :

« Establishment, Objectives, Technical Committees and Achievements » ASMO, P.O. Box 926161, Amman, Jordan.

ASMO frequently organises symposia and training courses (in 1980, 1981, 1982 and 1985). The papers presented of these events are published.

In addition a guide concerning metrological supervision was published in 1982 (Weights and Measures Inspection Guide) and a number of OIML Recommendations as well as the Vocabulary of Legal Metrology have been translated into Arabic.

Standards and Units

A brochure of 30 pages with the title « Etalons et Unités » was published in December 1984 by Bureau National de Métrologie, 8-10, rue Crillon, 75194 Paris Cedex 04.

This document was written by the Secretariat of BNM in cooperation with the Scientific Commission of the French metrology laboratories and constitutes a very valid training material concerning the SI-units and their scientific and practical realization.

United Kingdom, NPL publications

Several brochures describing the activities of the various departments of the National Physical Laboratory in Teddington were published in 1984 :

- NPL — A report on current work
- NPL — Customer services
- NPL — Annual Report

One may also note a new presentation of the review NPL News which contains popularized articles based on work made at NPL.

Metrology in Developing Countries

Japan organises regularly, on special invitation, courses and symposia for developing countries. The third symposium of this type took place from 17 to 21 September 1984. The papers presented are published in

« Proceedings of the 3rd International Symposium on Metrology and Measurement Standards in Developing Countries — ISMET 84 », published by Office of International Relations, National Research Laboratory of Metrology.

In addition to reports on the organisation of metrology in the participating countries (Indonesia, Philippines, Thailand, Korea, Malaysia, Singapore, China, India, Brazil and Japan) the volume also contains papers on Electronics in Legal Metrology (Netherlands), the Verification of Prepackages in Japan, A transportable absolute gravimeter (China) and as an introduction a lecture by F. Petik on the activities of OIML.

Regional workshops for developing countries are also organised by the Korean Standards Institute (KSI). The second of this kind took place Oct. 16-29, 1984 with 14 participants from the following countries : Bangladesh, Indonesia, Malaysia, Pakistan, Singapore, Sri Lanka and Thailand. The excellent physical standards facilities and know-how of KSI as well as calibration methods in various metrology fields were subject to presentations which have been printed in two volumes bearing the title

« Workshop on National Calibration System
and Precision Measurement Technology ».

The papers presented at the Training Workshop on Metrology and Standardization for developing countries and small island states, New Delhi 6-17 February 1984 organised jointly by the Commonwealth Science Council, UNESCO and NPL India with BIML participation, have now been printed in two volumes as CSC Technical Publication Series No. 158, CSC (85) ISP-4 and may be obtained from CSC Secretariat, Marlborough House, Pall Mall, London SW1Y 5HX.

Finally we would like to announce that the proceedings of the Regional Workshop on Metrology for Developing Countries, Sidney, September 1982 are now available in book-form under the title

P.L. Hewitt (ed.) : Modern Techniques in Metrology
publ. by Singapore World Scientific (distr. John Wiley, 1984).

Historical Metrology

The iconographic representation of the balance has been subject to a thesis at the University of Paris 1 :

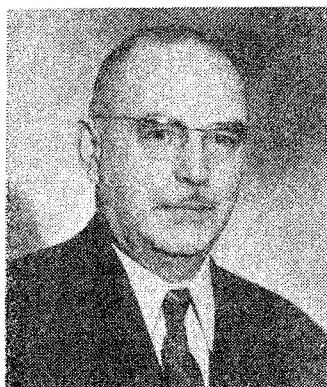
La balance, historique et iconographie du XIème au XVème siècle, Volume I (texte), 118 p., Volume 2 (planches), 195 p. Septembre 1984.

These roneotyped volumes present particular interest as concerns the illustrations and the accompanying descriptions.

It is possible to buy copies from the author : Mlle Christiane CHABALLIAN, 134, rue du Bac, 75007 PARIS.

Index to the OIML Bulletin

On the occasion of the issuing of No. 100 of the Bulletin, we are publishing as a supplement an Index to all the papers printed since the creation of the Bulletin in 1960.



IN MEMORIAM

FRANCIS VIAUD

1899-1985

Nous avons appris avec grande tristesse le décès, survenu le 24 juin 1985, de Francis VIAUD, Ingénieur Général honoraire et ancien Directeur du Service français des Instruments de Mesure, Membre d'Honneur du Comité International de Métrologie Légale.

Entré comme Ingénieur au Service des Poids et Mesures en 1929, sa tâche fut, en compagnie d'autres Ingénieurs de sa génération, de rénover et de restructurer cette administration qui n'avait pratiquement pas évolué depuis sa création en 1837. La modernisation fut autant administrative que technique, avec en particulier une révision des étalons qui devait prendre plusieurs années.

Très vite Francis VIAUD ressentit le besoin d'accompagner cette rénovation sur le plan national par un effort de coopération sur le plan international et il fut, avec entre autres Monsieur COSTAMAGNA, à la base de la Conférence Internationale de Métrologie Pratique de 1937, qui préfigurait l'OIML.

Membre du Comité International de Métrologie Légale et du Conseil de la Présidence de l'OIML, Francis VIAUD sut accorder à l'OIML et à la coopération métrologique internationale toute l'attention nécessaire. Jusqu'à sa retraite en 1969, il participa activement aux Conférences de l'OIML, aux réunions du CIML et aux activités de nombreux Secrétariats techniques, communiquant à nombre de ses Collaborateurs du Service des Instruments de Mesure son goût pour les travaux internationaux et les incitant à œuvrer activement en faveur de l'OIML.

Membre éminent de sociétés philosophiques, humanistes et sociales, Francis VIAUD a profondément marqué tous ceux qu'il a cotoyés par son élévation d'esprit, l'étendue de ses connaissances, son sens de l'organisation et ses talents exceptionnels d'orateur, qualités qui lui valurent de nombreuses décorations françaises, belges, espagnole, marocaine...

Il restera dans notre esprit comme l'un de ceux qui, à force de travail, de patience et de conviction, ont atteint leur objectif international, créer l'OIML.

B.A.

We have learned with deep sorrow of the death, on 24 June 1985, of Mr Francis VIAUD, Ingénieur Général honoraire and formerly Director of the French Metrology Service and Honorary Member of CIML.

When he started as Engineer in the Weights and Measures Service in 1929 his duty was, together with Colleagues of his generation, to renew and restructure this Administration which had practically not changed since its creation in 1837. The modernization was as much administrative as technical with, in particular, the renewal of the standards which took several years.

Francis VIAUD felt very soon the need for this national renovation to be accompanied by efforts of international cooperation and he was, together with among others Mr COSTA-MAGNA, at the base of the International Conference on Practical Metrology in 1937 which was the starting point for OIML.

As Member of CIML and of the OIML Presidential Council, Francis VIAUD gave all necessary support to OIML and generally to international cooperation in the field of metrology. He participated actively in OIML Conferences and CIML meetings, up to his retirement in 1969, and imparted to many of his Collaborators of the French Metrology Service his feeling for international work by inciting them to work actively for OIML.

Francis VIAUD was an eminent member of several philosophical, humanistic and social associations and has deeply impressed all those he met by his noble mind, the extent of his knowledge, his sense for organisation and his exceptional talent as speaker, qualities which resulted in a number of decorations : French, Belgian, Spanish, Moroccan, etc.

He will remain in our memory as one of those who due to work, patience and conviction has attained their international goal : creating the OIML.

INFORMATIONS

NOUVEAU MEMBRE CORRESPONDANT — NEW CORRESPONDING MEMBER

Le SULTANAT d'OMAN a été admis comme Membre Correspondant de l'OIML.

The SULTANATE of OMAN has been admitted as Corresponding Member of OIML.

NOUVEAUX MEMBRES DU CIML — NEW CIML MEMBERS

Nous sommes heureux d'accueillir les nouveaux Membres suivants du CIML :

We are happy to welcome the following CIML Members :

BRESIL	Juarez TAVORA VEADO
Rép. Pop. de CHINE	SONG YONGLIN
GRECE	DESI Athanassios
HONGRIE	Dezso BELEDI
IRLANDE	Patrick FANNING
TANZANIE	A.H.M. TUKAI

QUELQUES EVENEMENTS A VENIR — SOME COMING EVENTS

2-5 décembre 1985	9th International Exhibition MESUCORA, Porte de Versailles, Paris, France
10-11 mars 1986	Hardness Testing in Theory and Practice. Contact VDI/VDE Gesellschaft für Mess- und Regeltechnik, Postfach 1139, D-4000 Düsseldorf 1
12-16 mai 1986	11th Conference on Mechanical Problems in Measuring Force and Mass organized by IMEKO TC 3, Amsterdam, the Netherlands
9-12 juin 1986	Conference on flow measurements of gases and liquids. Information : Conference Section, National Engineering Laboratory, East Kilbride, Glasgow G75 0QU, U.K.
17-19 juin 1986	CAPTEURS 86 International Transducer Exhibition, Porte de Versailles, Paris
23-27 juin 1986	CPEM International Conference on Precision Electromagnetic Measurements. For information contact Betty Meiselman, National Bureau of Standards, B166 Metrology Building, Gaithersburg, MD 20899, USA
2-5 septembre 1986	INSYMET 86 — 8th International Symposium on Metrology, Czechoslovak Institute of Metrology, Bratislava
16-19 novembre 1986	International Symposium on Fluid Flow Measurement, Hyatt Hotel, Washington. For further information contact David E. Edgerly, Standards Management Program, Office of Product Standards Policy, National Bureau of Standards, Building 101, Room A 625, Gaithersburg, MD 20899, USA

REUNIONS

Groupes de travail		Dates	Lieux
SP 5D - Sr 1	Compteurs et ensembles de mesure de liquides autres que l'eau à chambres mesureuses ou à turbine	25-29 nov. 1985	PARIS FRANCE
SP 5D - Sr 7	Méthodes et dispositifs de vérification des instruments de mesure de liquides		
SP 6 - Sr 1	Compteurs de gaz à parois déformables	mai ou juin 1986 (provisoire)	PARIS FRANCE
SP 6 - Sr 2	Compteurs de gaz à pistons rotatifs. Compteurs de gaz non volumétriques		
SP 20 - Sr 1	Contenu informatif de l'étiquetage des produits préemballés	août ou sept. 1986 (provisoire)	
SP 20 - Sr 2	Vérification des quantités contenues dans les emballages		
Conseil de Développement		14-15 avril 1986	PARIS FRANCE
21ème Réunion du Comité International de Métrologie Légale		16-18 avril 1986	PARIS FRANCE

PUBLICATIONS

- Vocabulaire de métrologie légale
Vocabulary of legal metrology
- Vocabulaire international des termes fondamentaux et généraux de métrologie
International vocabulary of basic and general terms in metrology

RECOMMANDATIONS INTERNATIONALES

INTERNATIONAL RECOMMENDATIONS

RI N°

- 1 — Poids cylindriques de 1 g à 10 kg (de la classe de précision moyenne)
Cylindrical weights from 1 g to 10 kg (medium accuracy class)
- 2 — Poids parallélépipédiques de 5 à 50 kg (de la classe de précision moyenne)
Rectangular bar weights from 5 to 50 kg (medium accuracy class)
- 3 — Réglementation métrologique des instruments de pesage à fonctionnement non automatique
Metrological regulations for non automatic weighing instruments
- 4 — Fioles jaugées (à un trait) en verre
Volumetric flasks (one mark) in glass
- 5 — Compteurs de liquides autres que l'eau à chambres mesureuses
Meters for liquids other than water with measuring chambers
- 6 — Prescriptions générales pour les compteurs de volume de gaz
General specifications for volumetric gas meters
- 7 — Thermomètres médicaux (à mercure, en verre, avec dispositif à maximum)
Clinical thermometers (mercury-in-glass, with maximum device)
- 9 — Vérification et étalonnage des blocs de référence de dureté Brinell
Verification and calibration of Brinell hardness standardized blocks
- 10 — Vérification et étalonnage des blocs de référence de dureté Vickers
Verification and calibration of Vickers hardness standardized blocks
- 11 — Vérification et étalonnage des blocs de référence de dureté Rockwell B
Verification and calibration of Rockwell B hardness standardized blocks
- 12 — Vérification et étalonnage des blocs de référence de dureté Rockwell C
Verification and calibration of Rockwell C hardness standardized blocks
- 14 — Saccharimètres polarimétriques
Polarimetric saccharimeters

- 15 — Instruments de mesure de la masse à l'hectolitre des céréales
Instruments for measuring the hectolitre mass of cereals
- 16 — Manomètres des instruments de mesure de la tension artérielle (sphygmo-
manomètres)
Manometers for instruments for measuring blood pressure (sphygmomanometers)
- 17 — Manomètres, vacuomètres, manovacuumètres indicateurs
Indicating pressure gauges, vacuum gauges and pressure-vacuum gauges
- 18 — Pyromètres optiques à filament disparaissant
Optical pyrometers of the disappearing filament type
- 19 — Manomètres, vacuomètres, manovacuumètres enregistreurs
Recording pressure gauges, vacuum gauges, and pressure-vacuum gauges
- 20 — Poids des classes de précision E_1 E_2 F_1 F_2 M_1 de 50 kg à 1 mg
Weights of accuracy classes E_1 E_2 F_1 F_2 M_1 from 50 kg to 1 mg
- 21 — Taximètres
Taximeters
- 22 — Tables alcoométriques internationales
International alcoholometric tables
- 23 — Manomètres pour pneumatiques de véhicules automobiles
Tyre pressure gauges for motor vehicles
- 24 — Mètre étalon rigide pour agents de vérification
Standard one metre bar for verification officers
- 25 — Poids étalons pour agents de vérification
Standard weights for verification officers
- 26 — Seringues médicales
Medical syringes
- 27 — Compteurs de volume de liquides (autres que l'eau). Dispositifs complémentaires
Volume meters for liquids (other than water). Ancillary equipment
- 28 — Réglementation technique des instruments de pesage à fonctionnement non-
automatique
Technical regulations for non-automatic weighing machines
- 29 — Mesures de capacité de service
Capacity serving measures
- 30 — Mesures de longueur à bouts plans (calibres à bouts plans ou cales-étalons)
End standards of length (gauge blocks)
- 31 — Compteurs de volume de gaz à parois déformables
Diaphragm gas meters
- 32 — Compteurs de volume de gaz à pistons rotatifs et compteurs de volume de
gaz à turbine
Rotary piston gas meters and turbine gas meters

- 33 — Valeur conventionnelle du résultat des pesées dans l'air
Conventional value of the result of weighing in air
- 34 — Classes de précision des instruments de mesurage
Accuracy classes of measuring instruments
- 35 — Mesures matérialisées de longueur pour usages généraux
Material measures of length for general use
- 36 — Vérification des pénétrateurs des machines d'essai de dureté
Verification of indenters for hardness testing machines
- 37 — Vérification des machines d'essai de dureté (système Brinell)
Verification of hardness testing machines (Brinell system)
- 38 — Vérification des machines d'essai de dureté (système Vickers)
Verification of hardness testing machines (Vickers system)
- 39 — Vérification des machines d'essai de dureté (systèmes Rockwell B, F, T - C, A, N)
Verification of hardness testing machines (Rockwell systems B, F, T - C, A, N)
- 40 — Pipettes graduées étalons pour agents de vérification
Standard graduated pipettes for verification officers
- 41 — Burettes étalons pour agents de vérification
Standard burettes for verification officers
- 42 — Poinçons de métal pour agents de vérification
Metal stamps for verification officers
- 43 — Fioles étalons graduées en verre pour agents de vérification
Standard graduated glass flasks for verification officers
- 44 — Alcoomètres et aréomètres pour alcool et thermomètres utilisés en alcoométrie
Alcoholometers and alcohol hydrometers and thermometers for use in alcoholometry
- 45 — Tonneaux et futailles
Casks and barrels
- 46 — Compteurs d'énergie électrique active à branchement direct (de la classe 2)
Active electrical energy meters for direct connection (class 2)
- 47 — Poids étalons pour le contrôle des instruments de pesage de portée élevée
Standard weights for testing of high capacity weighing machines
- 48 — Lampes à ruban de tungstène pour l'étalonnage des pyromètres optiques
Tungsten ribbon lamps for calibration of optical pyrometers
- 49 — Compteurs d'eau (destinés au mesurage de l'eau froide)
Water meters (intended for the metering of cold water)
- 50 — Instruments de pesage totalisateurs continus à fonctionnement automatique
Continuous totalising automatic weighing machines
- 51 — Trieuses pondérales de contrôle et trieuses pondérales de classement
Checkweighing and weight grading machines
- 52 — Poids hexagonaux. Classe de précision ordinaire de 100 g à 50 kg
Hexagonal weights. Ordinary accuracy class, from 100 g to 50 kg
- 53 — Caractéristiques métrologiques des éléments récepteurs élastiques utilisés pour le mesurage de la pression. Méthodes de leur détermination
Metrological characteristics of elastic sensing elements used for measurement of pressure. Determination methods

- 54 — Echelle de pH des solutions aqueuses
pH scale for aqueous solutions
- 55 — Compteurs de vitesse, compteurs mécaniques de distances et chronotachygraphes des véhicules automobiles - Réglementation métrologique
Speedometers, mechanical odometers and chronotachographs for motor vehicles. Metrological regulations
- 56 — Solutions-étalons reproduisant la conductivité des électrolytes
Standard solutions reproducing the conductivity of electrolytes
- 57 — Ensembles de mesurage de liquides autres que l'eau équipés de compteurs de volumes. Dispositions générales
Measuring assemblies for liquids other than water fitted with volume meters. General provisions.
- 58 — Sonomètres
Sound level meters
- 59 — Humidimètres pour grains de céréales et graines oléagineuses
Moisture meters for cereal grains and oilseeds
- 60 — Réglementation métrologique des cellules de pesée
Metrological regulations for load cells
- 61 — Doseuses pondérales à fonctionnement automatique
Automatic gravimetric filling machines
- 62 — Caractéristiques des extensomètres métalliques à résistance
Performance characteristics of metallic resistance strain gages
- 63 — Tables de mesure du pétrole
Petroleum measurement tables
- 64 — Exigences générales pour les machines d'essai des matériaux
General requirements for materials testing machines
- 65 — Exigences pour les machines d'essai des matériaux en traction et en compression
Requirements for machines for tension and compression testing of materials
- 66 — Instruments mesureurs de longueurs
Length measuring instruments
- 67 — Ensembles de mesurage de liquides autres que l'eau équipés de compteurs de volumes. Contrôles métrologiques
Measuring assemblies for liquids other than water fitted with volume meters. Metrological controls
- 68 — Méthode d'étalonnage des cellules de conductivité
Calibration method for conductivity cells
- 69 — Viscosimètres à capillaire, en verre, pour la mesure de la viscosité cinématique
Glass capillary viscometers for the measurement of kinematic viscosity.
- 70 — Méthode pour la détermination des erreurs de base et de réversibilité des analyseurs de gaz
Method for the determination of intrinsic and hysteresis errors of gas analysers
- 71 — Réservoirs de stockage fixes à pression atmosphérique ou sous pression. Prescriptions générales
Fixed storage tanks at atmospheric pressure or under pressure. General requirements

- 72 — Compteurs d'eau destinés au mesurage de l'eau chaude
Hot-water meters
- 73 — Prescriptions pour les gaz purs CO, CO₂, CH₄, H₂, O₂, N₂ et Ar destinés à la préparation des mélanges de référence
Requirements concerning CO, CO₂, CH₄, H₂, O₂, N₂ and Ar pure gases intended for the preparation of reference gas mixtures

DOCUMENTS INTERNATIONAUX

INTERNATIONAL DOCUMENTS

DI N°

- 1 — Loi de métrologie
Law on metrology
- 2 — Unités de mesure légales
Legal units of measurement
- 3 — Qualification légale des instruments de mesurage
Legal qualification of measuring instruments
- 4 — Conditions d'installation et de stockage des compteurs d'eau froide
Installation and storage conditions for cold water meters
- 5 — Principes pour l'établissement des schémas de hiérarchie des instruments de mesure
Principles for the establishment of hierarchy schemes for measuring instruments
- 6 — Documentation pour les étalons et les dispositifs d'étalonnage
Documentation for measurement standards and calibration devices
- 7 — Evaluation des étalons de débitmétrie et des dispositifs utilisés pour l'essai des compteurs d'eau
The evaluation of flow standards and facilities used for testing water meters
- 8 — Principes concernant le choix, la reconnaissance officielle, l'utilisation et la conservation des étalons
Principles concerning choice, official recognition, use and conservation of measurement standards
- 9 — Principes de la surveillance métrologique
Principles of metrological supervision
- 10 — Conseils pour la détermination des intervalles de réétalonnage des équipements de mesure utilisés dans les laboratoires d'essais
Guidelines for the determination of recalibration intervals of measuring equipment used in testing laboratories

Note — Ces publications peuvent être acquises au / *These publications may be purchased from Bureau International de Métrologie Légale, 11, rue Turgot, 75009 PARIS.*

Les Recommandations Internationales 66 et 68 à 73 sont en cours d'impression.
The International Recommendations 66 and 68 to 73 are being printed.



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