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# BULLETIN

# DE

# L'ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE


BUREAU INTERNATIONAL DE METROLOGIE LEGALE
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## HUITIEME CONFERENCE INTERNATIONALE DE METROLOGIE LEGALE

La Huitième Conférence de l'OIML s'est tenue à Manly, station balnéaire de la banlieue de Sydney, du 24 au 28 octobre 1988 sur invitation du Gouvernement Australien.

38 Etats Membres et 3 Membres Correspondants de l'OIML, ainsi que 10 institutions internationales ou régionales en liaison, y avaient envoyé plus de 100 représentants, auxquels s'ajoutait une quarantaine d'observateurs Australiens et de pays non membres de la région Asie du sud-est et Pacifique, invités par la National Standards Commission.

La Conférence a été présidée par Monsieur P. RICHARDS, Chairman de la National Standards Commission, assisté de Messieurs R. LEWISCH (Autriche) et G.M. PUTERA (Indonésie), comme Vice-Présidents. Elle a été officiellement ouverte par une allocution de Monsieur Barry JONES, Ministre chargé des Sciences, des Douanes et des Affaires Diverses, à laquelle a succédé, présenté par Monsieur K. BIRKELAND, Président du Comité International de Métrologie Légale, un rapport couvrant l'activité de l'OIML au cours des quatre années écoulées et esquissant les développements futurs de notre activité (quelques extraits significatifs de ce rapport d'activité sont reproduits ci-après).

La Conférence a conduit à un certain nombre de décisions importantes pour l'avenir de l'OIML, en particulier dans le domaine de la certification où des actions urgentes devraient être menées dans les mois qui viennent.

La Conférence a par ailleurs sanctionné 26 Recommandations internationales dont 19 sur des sujets nouveaux et 7 constituant des révisions de Recommandations existantes ou déjà provisoirement adoptées par le Comité International de Métrologie Légale (voir titres de ces 26 Recommandations dans le précédent numéro du Bulletin).

Enfin la Conférence a fixé à 12 430 000 francs-or le budget de l'Organisation pour les quatre prochaines années (1 franc-or = 1,8145 franc-français).

La Conférence s'est déroulée par un merveilleux printemps et nos hôtes Australiens, en tout premier lieu Monsieur J. BIRCH, Directeur Exécutif de la National Standards Commission, ont parfaitement démontré à la fois leur talent d'organisateurs et leur sens de l'hospitalité. Diverses réceptions ont en effet permis à tous les participants et aux personnes les accompagnant de se retrouver tous ensemble et ceux qui n'étaient pas tenus d'assister à toutes les sessions ont même pu effectuer de très intéressantes visites dans Sydney ou ses alentours.

Une excursion a également été organisée pour voir les excellents laboratoires de la National Standards Commission et du National Measurement Laboratory. Certains participants ont par ailleurs prolongé leur séjour pour assister du 31 octobre au 2 novembre à un symposium organisé à l'occasion du cinquantenaire de ce dernier.

A l'issue de la réunion, les participants se sont donné rendez-vous pour la Neuvième Conférence, qui aura lieu en 1992 à Athènes ou à Salonique, sur invitation du Gouvernement de la Grèce.

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A l'occasion de la Conférence, le Comité International de Métrologie Légale a tenu sa 23e réunion, au cours de laquelle il a entre autres nommé ses deux nouveaux Vice-Présidents, Monsieur A.I. MEKHANNIKOV, U.R.S.S. et Monsieur S.E. CHAPPELL, Etats-Unis d'Amérique.

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Extraits du rapport d'activité présenté à la Conférence par Monsieur BIRKELAND, Président du Comité International de Métrologie Légale :

**1 — Sur la planification**

Le côté le plus positif de l'action de planification a été de donner l'occasion au Conseil de la Présidence, puis au Comité, de pénétrer à l'intérieur de tous les Secrétariats, d'examiner en détail leurs travaux passés et futurs.

Cela a permis d'éliminer certains travaux de moindre utilité, de mieux définir les spécificités de l'OIML et d'avoir une vue plus claire sur les priorités actuelles, telles qu'elles ressortent des besoins réels de nos Etats-membres.

Egalement, cette description détaillée des travaux de l'OIML permet une comparaison plus facile des programmes de travail des Secrétariats OIML entre eux et avec les programmes d'autres Institutions Internationales : on peut ainsi mieux identifier les domaines d'intérêt commun, les travaux qui risquent de se chevaucher ; on peut, si nécessaire, harmoniser les calendriers.

Enfin, le fait pour chaque Secrétariat de devoir se fixer un calendrier du déroulement des travaux, depuis le premier avant-projet jusqu'à l'approbation par la Conférence, a permis de réaliser combien ces délais peuvent, parfois, être longs.

La rapidité des progrès de la technique, les besoins parfois immédiats des Gouvernements, des Institutions Régionales ou des constructeurs, tout cela nous impose d'aller plus vite, aussi bien pour la mise au point de nouvelles Recommandations que pour la révision des Recommandations existantes.

**2 — Sur la certification**

Les constructeurs d'instruments de mesure ont de plus en plus besoin de recevoir rapidement, et pour tous les pays où ils veulent vendre leurs instruments, les homologations nécessaires.

Les services de métrologie ont eux à faire face à des tâches d'homologation toujours croissantes, avec des instruments de plus en plus sophistiqués qui nécessitent des moyens d'essai toujours plus complexes.

Tout cela milite en faveur d'une coopération internationale croissante visant à éviter que des contrôles identiques soient complètement effectués, sur les mêmes modèles d'instruments dans plusieurs pays. Sans faire perdre aux Etats leurs prérogatives nationales, sans créer aucune contrainte, il est possible d'apporter des réponses souples et adaptées aux problèmes ainsi posés.

Peut-être me permettrez-vous de livrer dès maintenant à vos réflexions une ou deux idées sur les conséquences que pourrait avoir la mise sur pied d'un système de reconnaissance mutuelle des essais et approbations de modèle et des vérifications.

A partir du moment où un instrument approuvé et vérifié dans un pays peut être introduit librement dans un deuxième pays sans avoir à subir de nouveaux contrôles initiaux, il devient clair que ce deuxième pays devra renforcer les contrôles ultérieurs, vérifications périodiques et surveillance, pour garantir non seulement le bon fonctionnement permanent de l'instrument, mais aussi pour pouvoir déceler aussi rapidement que possible l'introduction d'instruments mal ajustés, ou mal fabriqués, ou encore d'un modèle différent de celui qui a été approuvé. Les ressources en personnel libérées par la diminution des tâches d'approbation et de vérification permettront de renforcer les contrôles ultérieurs.

Les conséquences de ces contrôles ultérieurs renforcés pourront être, si les instruments en service se révèlent déficients, la demande au pays auteur de l'approbation de revoir celle-ci ou même de l'annuler, ou encore l'interdiction de l'accès sur le territoire du type d'instrument en question, et même la révocation de l'accord de reconnaissance. Bref, la métrologie légale prendra un aspect plus répressif, alors qu'actuellement, dans les cadres classiques de l'approbation de modèle et de la vérification primitive nationales, les services ont une action préventive : c'est l'Etat, par son service de métrologie légale, qui garantit le bon fonctionnement des instruments, par des contrôles a priori.

Pour l'OIML, cette évolution représente un nouveau défi, en particulier dans l'optique d'une maintenance correcte et crédible des instruments en service.

La valeur commerciale des instruments neufs, soumis à l'approbation de modèle et à la vérification, est bien sûr élevée. Mais la valeur marchande des produits mesurés avec ces instruments est incomparablement plus forte. En Norvège, par exemple, ce rapport est de un à cinq cents.

N'est-il donc pas approprié de répartir au mieux les ressources disponibles entre contrôles préventifs faits a priori et contrôles de type plus répressif faits sur les instruments en service ?

Et si ce point de vue est reconnu comme acceptable, ne faudrait-il pas que l'OIML en tienne compte dans l'élaboration de ses Recommandations Internationales ? Jusqu'à maintenant, l'accent a été mis sur les essais de modèle, et à un moindre degré sur la vérification primitive.

Vérifications ultérieures et surveillance en service ont été considérées comme relevant des prérogatives nationales et ne nécessitant donc pas d'action d'harmonisation de la part de l'OIML. Peut-être faudrait-il maintenant reconsidérer ce point et examiner l'opportunité, pour l'OIML, de développer des travaux qui permettront, dans la mesure du nécessaire, d'harmoniser ces contrôles ultérieurs, en vue d'obtenir une uniformité globale des résultats de mesure, ce qui est, en fait, l'objectif ultime de l'OIML.

**3 — Evolutions de la métrologie légale**

Je pense que, au cours de ces dernières années, trois évolutions principalement ont affecté la métrologie, les Services nationaux et l'OIML. Il s'agit :

a) — de l'interaction métrologie-essais

b) — de nouvelles approches réglementaires

c) — de nouvelles approches en ce qui concerne l'application des contrôles métrologiques et la structure des organismes nationaux chargés de cette application.

a) — Le commerce international toujours croissant des produits, matières ou objets et la nécessité de réduire la multiplicité des essais auxquels ils peuvent être soumis, a conduit à un énorme effort de coopération internationale dont un exemple important est la Conférence Internationale d'Accréditation des Laboratoires d'Essai qui s'est tenue la semaine dernière à Auckland.

Mais d'autres forums internationaux existent : la Commission Economique pour l'Europe des Nations Unies, la RILEM et bien sûr l'ISO et la CEI.

Au sein de certains de ces forums, un cheminement identique de la pensée ou de l'action est apparu. Partant des essais, on est arrivé aux mesurages qui constituent la base d'une très large partie de ces essais, et à la nécessité d'harmoniser les résultats de ces mesurages, ce qui se traduit par traçabilité des étalons, contrôle des instruments de mesure, périodicité des réétalonnages, expression des résultats de mesure, etc.

Cette démarche est tout à fait correcte. Le seul problème, que j'ai personnellement constaté à plusieurs reprises tant au niveau international qu'au niveau de certains pays, est que les responsables des essais étaient parfois ignorants des structures métrologiques existantes et, face à un problème de mesurage, envisageaient de reconstruire une métrologie adaptée à leurs besoins, au lieu d'utiliser ce qui était déjà à leur disposition. Est-ce dû à un manque de publicité par les organes nationaux de métrologie, des services qu'ils peuvent offrir ? Ou à une action d'information trop limitée de la part des organismes métrologiques internationaux ? Je pense qu'il convient qu'au sein de l'OIML nous réfléchissions à cette situation et à la manière d'éviter que de nouvelles structures métrologiques ne soient inutilement établies. Au mieux, elles feraient double emploi avec les structures existantes ; au pire, elles en divergeraient, introduisant contradictions et désordre.

b) — En ce qui concerne les nouvelles approches réglementaires, un cas type mérite d'être mentionné. Il y a environ trois ans, le Conseil des Communautés Européennes a adopté de nouvelles modalités pour établir les réglementations techniques communes aux douze pays européens qui composent le Marché Commun : les réglementations proprement dites, celles qui ont un caractère obligatoire, doivent être limitées aux exigences essentielles, et complétées par des normes, à caractère non obligatoire qui présentent de façon détaillée une manière de satisfaire aux exigences, la conformité aux normes étant une présomption de conformité aux réglementations.

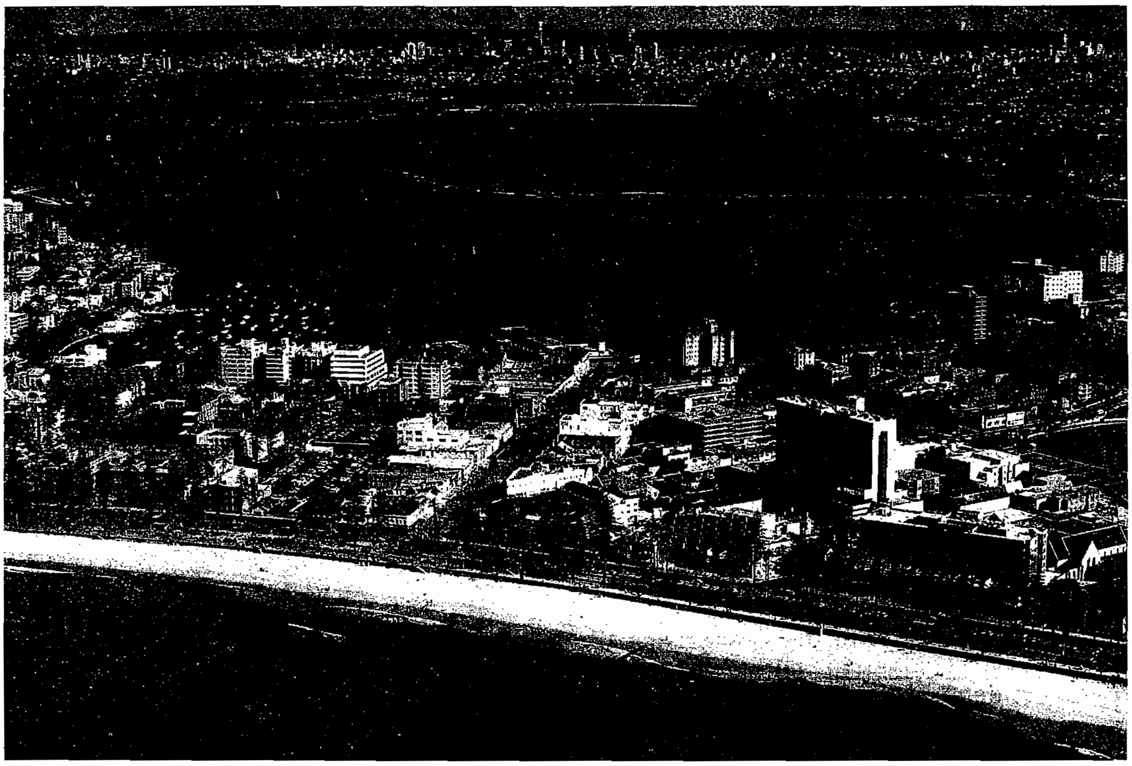
Cette nouvelle approche réglementaire, en rupture avec ce qui avait été fait dans le passé, ne concerne pas seulement les douze Etats du Marché Commun. Les cinq Etats de l'Association Européenne de Libre Echange, dans leur rapprochement avec le Marché Commun, sont également concernés. C'est donc un groupe important de dix-sept Etats, parmi les plus industrialisés du monde, qui rompt ou envisage de rompre certaines habitudes réglementaires sur lesquelles s'était construit le mode de travail de l'OIML.

Notre Organisation est mondiale ; elle ne doit donc pas se plier aux seules exigences d'un groupe de pays, mais doit satisfaire tous ses Etats Membres, même si leurs besoins sont formellement différents.

c) — Certains Etats recherchent de nouvelles modalités d'application des contrôles métrologiques, ou de nouveaux types d'organes de métrologie nationaux, pour répondre à des besoins qui, progressivement, apparaissent : utilisation de procédures de certification, participation à la conception des instruments, auto-vérification par le constructeur, tout cela peut remplacer essais de modèle et vérification primitive dans leur conception classique.

De même, l'utilisation de laboratoires privés pour réaliser les contrôles métrologiques modifie les structures classiques des Services nationaux de métrologie légale.

Là encore les travaux de l'OIML doivent, peut-être, être réorientés pour pouvoir être utilisés avec les mêmes bénéfices par tous les pays quelle que soit leur structure nationale, quels que soient les modes de contrôle métrologique appliqués.



## THE EIGHTH INTERNATIONAL CONFERENCE OF LEGAL METROLOGY

The Eighth Conference of OIML took place from 24 to 28 October 1988 at Manly, a seaside suburb of Sydney, on invitation by the Australian Government.

The participation included more than 100 delegates from 38 Member States, 3 Corresponding Members and 10 international or regional institutions cooperating with OIML. There were also about forty observers from Australia and from the South East Asia-Pacific region specially invited by the National Standards Commission.

The Conference was presided by Mr P. RICHARDS, Chairman of the National Standards Commission. He was assisted as Vice-Chairmen by Mr R. LEWISCH (Austria) and Mr G.M. PUTERA (Indonesia). The Conference was officially opened by Mr Barry JONES, Minister of Science, Customs and Small Business. His speech was followed by a presentation by Mr K. BIRKELAND, President of the International Committee of Legal Metrology who gave an account of the activities of OIML during the last four years and sketched the expected future developments (some significant extracts of this report are reproduced below).

The Conference took some important decisions for the future of OIML, in particular as regards certification for which urgent actions are expected to be taken in the following months.

The Conference also sanctioned 26 International Recommendations out of which 19 concern new subjects and 7 are revisions of already existing ones or Recommendations which had provisionally been adopted by the International Committee of Legal Metrology (see full list of these Recommendations in the preceding issue of the OIML Bulletin).

The Conference finally set the budget of OIML to 12 430 000 gold francs for the 4 year period to come (1 gold franc = 1.8145 French franc).

The Conference was held during a marvellous springtime weather and our Australian friends, in particular Mr J. BIRCH, Executive Director of the National Standards Commission, perfectly showed both their talents as organizers and their sense of hospitality. Various receptions gathered together all the participants and accompanying persons and those which were not obliged to attend all the sessions were given the opportunity to make interesting visits in Sydney and its surroundings.

One excursion was also organized to see the excellent laboratory facilities of the National Standards Commission and those of the National Measurement Laboratory. Some of the participants extended their stay to attend from 31 October to 2 November at a symposium organized by the latter at the occasion of its 50th anniversary.

The Conference ended by deciding on the venue of the 9th Conference which will take place in 1992 in Athens or Saloniki at the invitation of the Government of Greece.

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In connection with the Conference the International Committee of Legal Metrology held its 23rd meeting during which it among other matters nominated its new Vice-Presidents A.I. MEKHANNIKOV, U.S.S.R. and S.E. CHAPPELL, U.S.A.

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Extracts from the report presented by Mr K. BIRKELAND, President of the International Committee of Legal Metrology :

**1 — Concerning planning**

The most positive outcome of planning has been the opportunity given to the Presidential Council and to the Committee to get inside each of the Secretariats, to study in detail their past and future work.

It has been possible to eliminate some work of lesser value, to better define what is specific to OIML and to give a clearer view of current priorities, those which arise from the real needs of our Member States.

Moreover this detailed description of OIML's work makes easier a comparison of the work programmes of OIML Secretariats, with each other and with the programmes of other international institutions : the fields of common interest and the risks of overlap are thus more readily identified ; timetables can, if necessary, be made to intermesh.

In addition the fact that each Secretariat must fix a timetable for the progress of the work, from the first preliminary draft to approval by the Conference, has made us realise how long some of the delays can be.

The pace of technical progress, the sometimes pressing needs of governments, of regional institutions and of manufacturers, all oblige us to move faster, both in the development of new Recommendations and in the revision of existing ones.

**2 — Concerning certification**

Manufacturers need increasingly to obtain as quickly as possible official approval of their instruments in all the countries in which they wish to sell them.

The metrological services themselves are having to face up to an ever increasing amount of approval work for instruments which become more and more complicated, requiring ever more complex test equipment.

All that increased work militates in favour of increasing international cooperation to avoid the complete application of identical controls on the same patterns of instruments in more than one country. Without causing any loss of the States' national prerogatives, without imposing any constraints, it is possible to find flexible solutions adapted to the problems that arise.

Perhaps you will allow me now to offer you one or two ideas for your consideration on the consequences which might follow the setting up of a scheme for the mutual recognition of the results of tests and pattern approvals, and of the results of verification.

From the time when an instrument, which has been approved and verified in one country, is freely introduced in a second country without having to be submitted anew to initial controls, it becomes clear that this second country will have to reinforce its subsequent controls, periodic verification and surveillance, to ensure not only that the instrument works well all the time, but also to detect as quickly as possible the introduction of badly adjusted or badly made instruments, or even of a pattern which is different from that which has been approved. The resources that have been freed by the reduction in the work of pattern approval and initial verification will be available to reinforce subsequent controls.

A consequence of these reinforced subsequent controls could be, if the instruments prove to be inadequate in service, a request to the country which approved the pattern to review its approval or even to revoke it, or perhaps the banning of the type of instrument concerned from the national territory, or even a rescinding of the recognition agreement. Briefly, legal metrology will take on a more repressive aspect, when now, in the classic mould of pattern approval and initial verification, the metrological services have a preventive role : it is the State that, through its services of legal metrology, ensures that instruments perform satisfactorily by means of anticipatory controls.

For OIML it represents a new challenge, particularly when it comes to the credible and proper maintenance of instruments in service.

The commercial value of new instruments that have been submitted to pattern approval and verification is certainly great. But the market value of the commodities measured by these instruments is incomparably greater. In Norway, for example, this ratio is five hundred to one.

Is it not, therefore, appropriate that the available resources be better apportioned between preventive controls applied in advance and controls of a more repressive nature applied to instruments in service ?

And if this is an acceptable view of the matter, should OIML not take account of it in developing its International Recommendations ? Hitherto the emphasis has been on type testing of patterns, and to a lesser degree on initial verification.

Subsequent verification and surveillance have been considered as a national prerogative and so not in need of the harmonising influence of OIML. Perhaps the time has come to think again and to consider whether the time is opportune for OIML to take some initiatives aimed, so far as they are needed, at promoting a greater accord with regard to subsequent controls, to obtain a world-wide uniformity in the results of measurement, which is in fact the ultimate aim of OIML.

**3 — Concerning the evolution affecting legal metrology**

It seems to me that during the last few years three particular forms of evolution have affected metrology, the national services and OIML. I am speaking here of :

a) — the interaction between metrology and testing,

b) — new approaches in the making of regulations,

c) — new approaches in the application of metrological controls and in the structures of the national organisations whose task is to apply them.

a) — International trade in commodities, materials and artefacts increases continually, and the necessity to reduce the multiplicity of tests to which they may be subjected has led to an enormous international co-operative effort of which one important example is the International Laboratory Accreditation Conference which was held in Auckland last week.

But there are other international forums : the Economic Commission for Europe of the United Nations, RILEM and, of course, ISO and IEC.

Within some of these forums an identical path of thought and action has emerged. From testing one came to the measurements on which the tests are very largely based, and the necessity that the results of these measurements are in agreement, expressed in the form of the traceability of standards, the checking of measuring instruments, the frequency of recalibration, the expression of the results of measurement, etc.

This way of proceeding is quite right. The only difficulty, as I personally have encountered more than once — as much at the international level as within some countries — is that the people responsible for the tests were sometimes unaware of the existing metrological structures and, faced with a problem in measurement, tried to reconstruct a metrology adapted to their needs rather than use that which was already available to them. Is this due to a lack of publicity on the part of the national metrological organisations on the services that they can offer ? Or to informative action by the international metrological organisations which is too restricted ? I think that we in OIML ought to think about this situation and about how we can avoid new metrological structures being unnecessarily created. At best they will duplicate existing structures ; at worst they will diverge from them, sowing contradiction and disorder.

b) — As regards the new approaches to regulation, it is worth mentioning a typical case. About three years ago the Council of the European Communities adopted a new method of enacting the technical regulations which are common to the twelve European countries which make up the European Economic Community. I think that you are all more or less familiar with this new method. To summarise it briefly, the regulations proper, those which are obligatory by nature, must be limited to the essential requirements, and they must be supplemented by standards, which are not themselves obligatory but which give in detail the way in which the requirements may be satisfied. Conformity with the standard is deemed to constitute conformity with the regulations.

This new regulatory approach, which is a break from the past, concerns not only the twelve states of the European Economic Community. The five states of the European Free Trade Association, in their close association with that European Community, are also affected. Thus an important group of seventeen states, among the most industrialised in the world, are breaking with, or are planning to break with some of the habits along which OIML's way of working is based.

Ours is a world-wide organisation ; it can consequently not bend itself to the exclusive will of a group of countries, but must yet satisfy all its Member States, even if their needs are, strictly speaking, various.

c) — Some states are seeking new ways of applying metrological controls, or new types of national metrological organisations, to meet needs which are gradually emerging : the use of certification procedures, the participation in the development of instruments, the self-verification by the manufacturer, all these developments can replace the classically conventional pattern testing and initial verification.

Similarly, the use of private laboratories for the application of metrological controls changes the classical structures of national organisations of legal metrology.

Here again, OIML's work must perhaps change direction, so that the results may be used to the same advantage by all countries, whatever their national structures, whatever the manner in which their metrological controls are applied.

# PRINCIPLES and VERIFICATION of SELECTIVE AUTOMATIC GRAVIMETRIC FILLING MACHINES *

by E. DEBLER and H.A. OEHRING
Physikalisch-Technische Bundesanstalt, Braunschweig

## 1. Introduction

Automatic gravimetric filling machines (AGFM's) are defined as " weighing machines which sub-divide a bulk product into loads of predetermined and virtually constant mass by automatic weighing, ... " (RI 61 point 3.1) [1]. These filling masses are subject to variations whose maximum range of dispersion has been defined (RI 61 point 4.1). In order to comply with the specified ranges of dispersion, AGFM's have two- or three-stage feeding devices (RI 61 point 3.3.1) which — first of all — feed the product to be weighed in coarse feed to the load receptor for quick filling, and then in fine feed to guarantee a precise net quantity. In the case of products in small but varying sizes — for example potatoes, the fine feed may feed individual particles, but despite this, the filling masses are affected by deviations which are greater than half the mean particle mass. The selective weighers developed in the last few years have been specially designed to allow the exact filling of bulk products composed of small particles.

## 2. Principle

In contrast to conventional AGFM's, selective weighers produce the net contents in packages by filling and weighing subloads of a small proportion of the nominal filling masses and make them up with the aid of a computer. As there are numerous possibilities for making up filling masses from subloads there is a large variety of designs and differing designations of selective weighers : Selective combination weighers, separating weighers, multi-head net weighers, computer balances (trade name) etc. Despite their variety, these types of weighing machine may be devided into two main categories.

### 2.1 Selective accumulation weighers

The arrangement shown in Fig. 1a comprises a weighing machine and several reservoirs. A computer decides to which reservoir the respective subload weighed will be fed. The filling mass is formed by loads being accumulated step-by-step. This is why this type of weighing machine may be referred to as a selective accumulation weigher. In the Federal Republic of Germany, it is not widely used, and will not be described here.

(*) Enlarged version of a lecture held on the occasion of the IX. Hungarian colloquium on weighing technology on September 3rd, 1987 in Szeged.

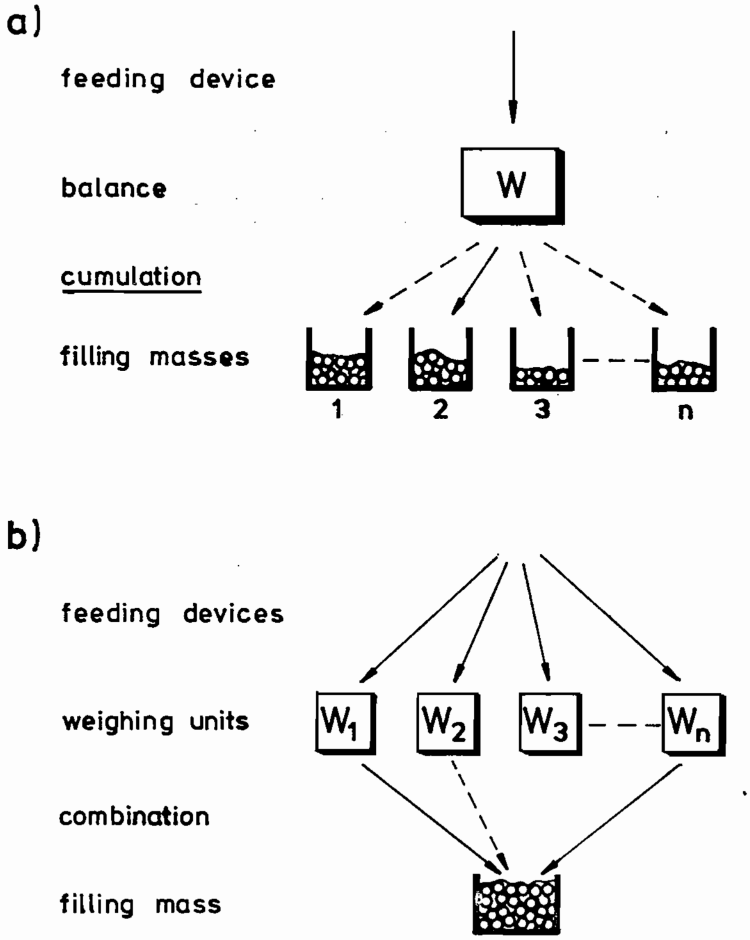


Fig. 1 — Principles of selective weighers
a) selective accumulation weigher
b) selective combination weigher

### 2.2 **Selective combination weighers (SCW)**

At present, selective combination weighers (Figs. 1b, 2a and 2b) with up to 28 weighing units are constructed. The number of subloads corresponds to the number of weighing units. A computer selects the subloads the combination of which will make up the preset filling mass. When $k$ subloads — usually three to five — are selected for one filling from a total of $n$ subloads available, the total number $z$ of all combinations is :

$$z = \frac{n\,!}{k\,!\;(n - k)\,!}.$$

Depending on the number of weighing units and the programme used, between approx. 200 and 10 000 combinations of subloads exist which are combined and interrelated (Table I).

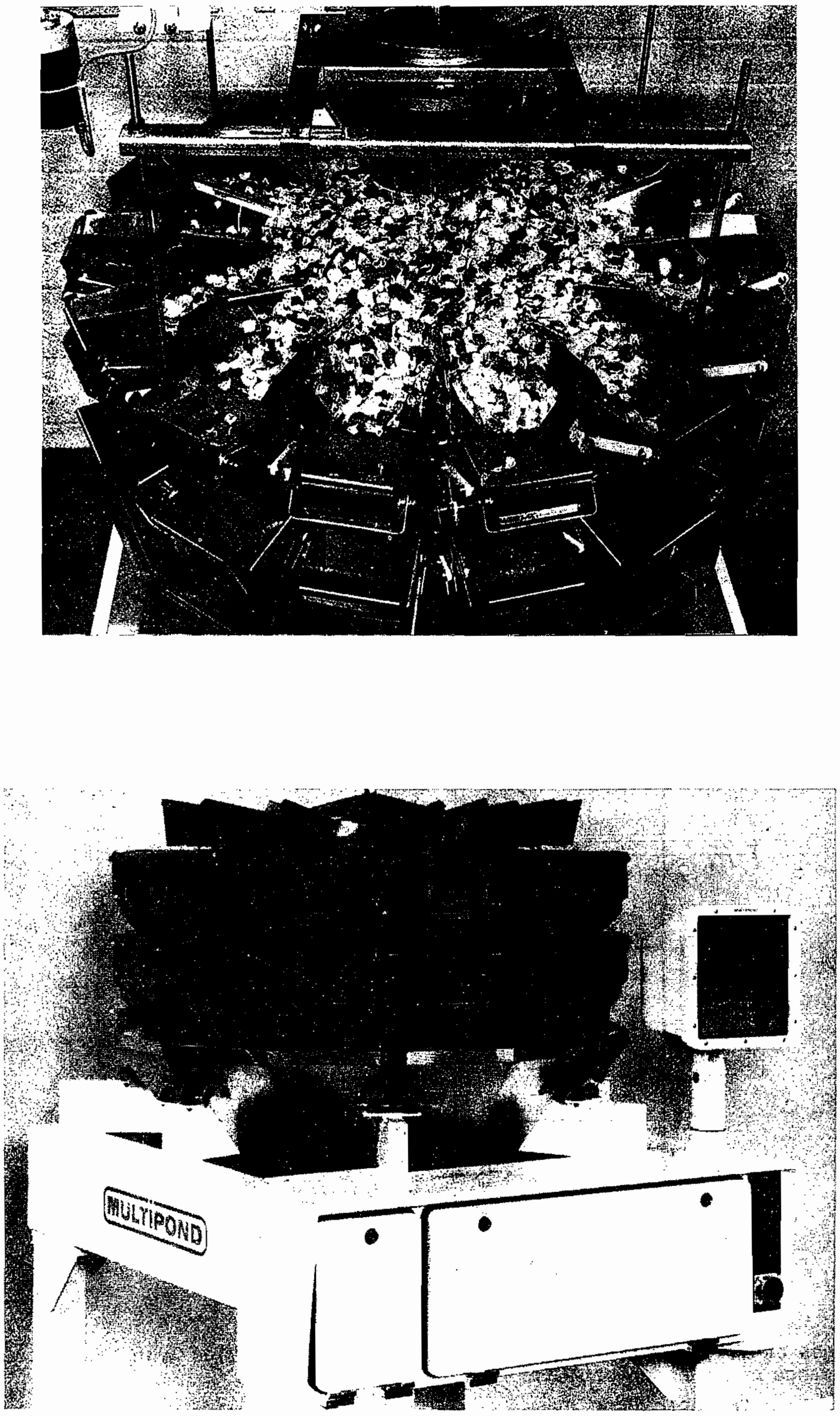


Fig. 2 — Selective combination weighers of two manufacturers, each with 14 weighing units
a) top view
b) side view

Table I — Number of combinations as a function of $n$ and $k$

| $n$ \ $k$ | 3 | 4 | 5 |
|---|---|---|---|
| 10 | 120 | 210 | 252 |
| 15 | 455 | 1 365 | 3 003 |
| 20 | 1 140 | 4 845 | 15 504 |

With the aid of microprocessors, the extensive calculation work can be carried out in fractions of a second.

Depending on the product to be weighed and the number of weighing units, 120 and more fillings may be carried out per minute.

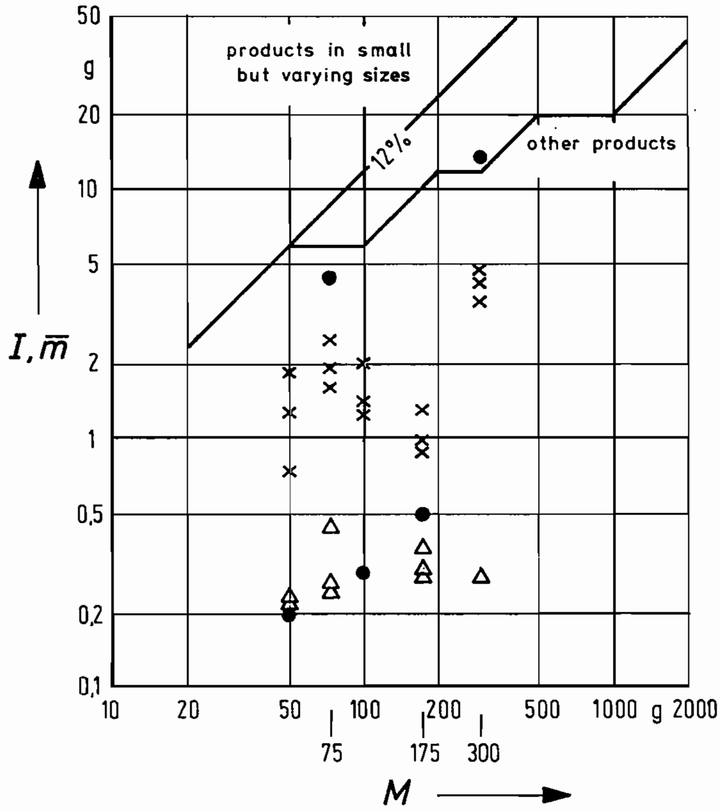


Fig. 3 — Ranges of dispersion of the filling masses of SCW's compared with OIML requirements for the range of dispersion of AGFM's and particle masses $m$

| | |
|---|---|
| $M$ | nominal filling mass |
| $I$ | range of dispersion |
| —— | maximum range of dispersion $I_p$ on pattern approval and verification |
| × | ranges of dispersion $I_{SCW}$ |
| • | mean particle mass $\overline{m}$ |
| Δ | mean deviation of the filling mass from the nominal filling mass |

The advantages of SCW's become evident when the products to be filled are discrete particles. Fillings with coconut macaroons, for example, — mean particle mass 13.3 g — showed deviations of the filling masses of ± 1,9 g, which is less than one third of the deviations of conventional AGFM's.

The SCW's shown in Figs. 2a and b feed the bulk product from a central distribution station over time-controlled vibrating channels into the load receptors of the weighing instruments and then, after an appropriate combination has been chosen, into the package. The next weighing cycle starts while the emptied load receptors are being refilled.

## 3. Accuracy

Because of the principle on which they are based, in addition to filling predetermined masses, SCW's also furnish the mass values of the filled-in masses produced. They may therefore be assessed from two aspects :

— on the basis of the deviations of the filling masses from the nominal mass of filling,

— on the basis of the deviations of the indicated mass values from the actual filling mass.

Both types of deviations were determined on three SCW's with bulk products of different mean particle masses and different nominal filling masses (Table II and [2]) by reweighing the fillings with a checkweigher (RI 61 point 11.1.2). In the following, the deviations are compared with OIML requirements.

Table II — Mean particle masses and nominal filling masses of the products used in the investigations.

| Product filled | Mean particle mass in g | Nominal mass of filling in g |
|---|---|---|
| Kernels of maize | 0.2 | 50 |
| Sweets | 4.5 | 75 |
| Potato crisps | 0.3 | 100 |
| Spiral noodles | 0.5 | 175 |
| Coconut macaroons | 13.3 | 300 |

### 3.1 Comparison with requirements for automatic gravimetric filling machines (AGFM's)

The following criteria characterize the accuracy of the filling of an AGFM :

— the maximum range of dispersion $l$ (RI 61 points 3.4.8 and 4),

— the static setting error (RI 61 points 3.4.9 and 4.4),

— the variation of static set point with temperature (RI 61 points 3.4.10 and 4.5), and

— the variation of static set point with time (RI 61 points 3.4.11 and 4.6).

Fig. 3 shows measurement results :

— crosses x represent the ranges of dispersion $l_{SCW}$ of the SCW's investigated,

— filled-in circles • represent the mean particle masses $\overline{m}$, and

— triangles Δ the mean deviations of the filling masses from the nominal filling masses.

In addition, the maximum ranges of dispersion $l_p$ of the AGFM according to RI 61 are shown for bulk products in particles and whole bulk products (unbroken lines).

The ranges of dispersion $l_{SCW}$ (crosses x) lie below the maximum range of dispersion $l_p$ (on pattern approval and initial verification) for whole bulk products (unbroken lower line). The two filling products in particles with mean particle masses of 4,5 and 13,3 g (filled-in circles •) also take up less than half the range of dispersion $l_p$ for whole bulk products. The low ranges of dispersion demonstrate the advantage of SCW's previously mentioned, i.e. a more precise filling of bulk products in pieces than other AGFM's.

The other above-mentioned criteria have not been individually determined. It is assumed that they are complied with, as the mean deviation of the filling masses from the nominal filling masses are extraordinarily low, as they amount to less than 1/10th of the range of dispersion $l_p$ (triangles Δ in Fig. 3).

### 3.2 Comparison with requirements for measuring instruments to control the net contents of prepacks

The OIML draft on the net contents of prepacks specifies under the key words "acceptable individual deviations" the maximum value $T$ of the negative deviations from the nominal filling mass ([3], Appendix B, Table I). It also requires that "The official determination of net contents shall be exact to ± 0,2 $T$" ([3] point 3). Fig. 4 shows to what extent the SCW's investigated comply with this requirement. The following are shown :

— the extreme values $A_E$ (circles o) of all deviations $A_i$ of the mass values indicated, and

— the mean value $A$ of the deviations $A_i$ (triangles Δ).

Each of the deviations $A_i$ (circles o) lies within the limit of ± 0,2 $T$ (broken line) ; on an average, the deviations $A_i$ remain clearly below the limit of ± 0,2 $T$ by a factor of > 3.

The draft [3] does not specify the measuring instruments to be used for control. Both non-automatic weighing machines and checkweighers are used. Non-automatic weighing machines allow the filling masses to be controlled by random sampling. The deviations of these weighing machines are determined by the verification interval $e$ (RI 3 point 7) [4] which may be so selected that the ± 0.2 $T$ limit is complied with.

Any prepackaging can be controlled with checkweighers. The actual zone of indecision $U_a$ has been adopted as an essential criterion (RI 51 points 2.7.8.3 and 4.1.2) [5]. The zone of indecision $U_{SCW}$ of the SCW's investigated (points • in Fig. 5) exceeds the required $U_a$ values, in particular in the case of filling masses of up to 100 g. This may be due to vibration during the automatic operation of these weighing machines, once per prepack in the case of checkweighers and $k$ times in the case of SCW's, depending on the number of subloads.

From the measuring result obtained it can be concluded that SCW's are well able to meet the requirements relevant for AGFM's and that they may be used simultaneously to control the net contents of prepacks even though they do not at present, meet the requirements of the RI 51 for checkweighers.

## 4. Handling during verification

When an SCW is not only used to fill packages of equal weight, but also to check the filling mass it must be possible to check both these functions — the filling and the determination of the mass — during pattern approval and verification. Here, it must be taken into account that each filling mass is composed of several subloads whose mass values have been summed up, and that each weighing unit must be individually tested. Consequently, SCW's must be tested in two steps, as must any other automatic weighing machine, i.e. statically and in automatic operation.

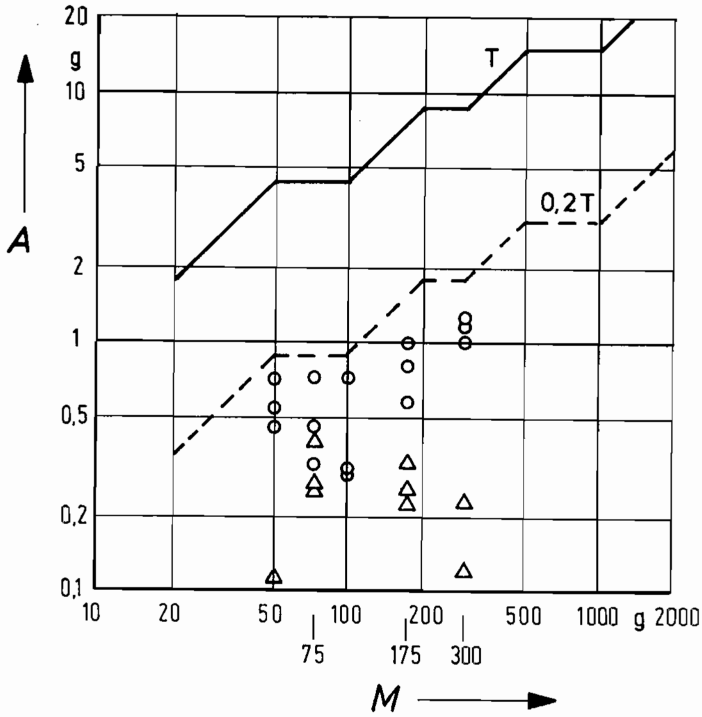


Fig. 4 — Comparison of the measurement results with the requirements for the nominal filling masses (net contents) of prepacks

*A* deviation

*M* nominal filling mass

——— maximum admissible negative deviation *T* of the nominal filling masses according to OIML draft [3]

– – – requirements for the accuracy of a checkweigher for determining the nominal filling masses

o largest deviations $A_E$ of the actual filling masses from the weight values printed by the three SCW's investigated

Δ mean values *A* of the deviations $A_i$

### 4.1 Static tests

As in the case of every weighing machine, static tests are carried out by placing weights on the load receptors and comparing the value indicated by the SCW with the placed mass. In accordance with section 3.2, the deviations determined in this way may be assumed to be small ; the important deviations are caused by vibration during automatic operation. Static tests are nevertheless necessary, as they are an easy means of detecting maladjusted weighing units.

Static tests are made easier by the small scale intervals of the weighing units. The manufacturers usually choose as scale interval *d* one tenth or one fifth of the verification interval *e* of the total device. The errors can thus be determined without the aid of make-weights.

### 4.2 Tests in automatic operation

To carry out the above-mentioned tests, a larger number of fillings — at least 50 — must be checked by a non-automatic weighing machine. This allows the deviations of the fillings from the nominal filling mass and the deviations of the mass values of the SCW from the actual filling mass to be determined at the same time. These dynamic tests detect the greatest deviations of the SCW. The range of dispersion $l_p$ of the filling masses and/or the limit of ± 0.2 *T* must not be exceeded.

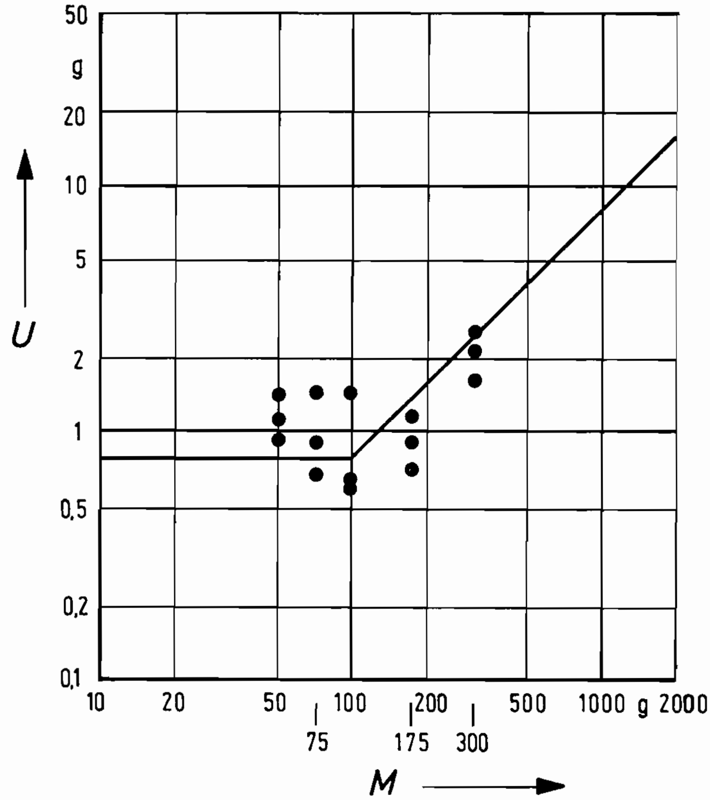


Fig. 5 — Comparison of the zones of indecision
——— actual zone of indecision $U_a$ according to RI 51
• zone of indecision $U_{SCW}$ of the three SCW's investigated

## 4.3 **Other tests**

Other tests are carried out in accordance with the requirements of RI 3 and RI 28 for non-automatic weighing machines and RI 74 for electronic devices incorporated in weighing machines [4,6,7]. In the Recommendations for automatic weighing machines, some of these requirements are repeated (e.g. RI 28 chapter I point 1 and RI 61 point 6), in some cases they are referred to as a whole. As they do not deal specifically with SCW's, it is unnecessary to go into detail here.

# 5. **Concluding remarks**

Selective combination weighers are complex instruments which combine two functions, the filling and the determination of the mass. Their particular advantage is their precise filling of products in pieces. Despite their high cost, they are being used in large numbers. As SCW's make another measuring instrument for the determination of the actual filling mass unnecessary, they are also increasingly used to control the net contents of prepacks. As has been demonstrated, SCW's can meet existing requirements.

When more experience is available, it will be necessary to clarify whether a separate RI must be drawn up for SCW's or whether it will be sufficient to incorporate them by supplementing the existing International Recommendation on AGFM's.

**Literature**

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[3] First draft of an International Recommendation : Net contents of Prepacks, OIML, January 1987.

[4] International Recommendation No. 3 : Metrological Regulations for Non-Automatic Weighing Instruments, OIML, October 1984.

[5] International Recommendation No. 51 : Checkweighing and Weight Grading Machines, OIML, October 1984.

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**ROYAUME-UNI**

# The DEVELOPMENT, CALIBRATION and IMPLEMENTATION of METERING SYSTEMS on EX FARM BULK MILK VACUUM TANKERS in ENGLAND and WALES *


by **J.W. BURGESS**

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*SUMMARY — The author first explains the role of the Milk Marketing Board of England and Wales, which acting as a farmer's cooperative for 37 000 milk producers, collects the milk and finds a market for it.*

*This organisation has its own calibration centre for calibrating the turbine (or electromagnetic) flowmeters installed on most of the 2 000 tank trucks operated by haulers under contract. The paper gives a detailed account of the metrological, technical and administrative aspects of the milk metering for which the Board is responsible in cooperation with the legal authorities.*

*RESUME — L'auteur explique d'abord le rôle du Milk Marketing Board (Comité de commercialisation du lait) d'Angleterre et du Pays de Galles qui, sous forme de coopérative, groupe 37 000 producteurs de lait, prend livraison du lait et s'occupe de sa commercialisation.*

*Cette organisation a son propre centre d'étalonnage pour les compteurs turbine (ou électromagnétiques) installés sur un grand nombre des 2 000 camions citernes de ramassage gérés ou appartenant à des transporteurs sous contrat. L'exposé comporte une description détaillée des aspects métrologiques, techniques et administratifs de comptage du lait dont l'organisation est menée en coopération avec les autorités légales.*


## 1 Introduction

### 1.1 The role and operational structure of the Milk Marketing Board (MMB) of England and Wales

It is important to understand the relationship of the MMB within the dairy industry and the various legislative bodies as this effects the method and control of all milk collections.

The MMB of England and Wales was formed under an Act of Parliament in 1933 and most simply could be described as a type of farmers co-operative. It operates as an independant producers organisation, under the authority of registered milk pro-

* Presented at the OIML seminar on Calibration of Liquid Volume Measuring Installations, Arles, France, 11-15 May 1987.

ducers. A registered producer is required to sell milk solely to the Board or through its agency. The Board having a statutory obligation to buy and find a market for all milk offered for sale, provided it complies with certain marketing standards of quality.

The milk is measured on the farm by the haulier, either by dipstick (81 %) or meter (19 %), churn (can) collection having ceased in 1979, and the producer is paid on that measurement. The milk is then sold to the various buyers, with the delivered quantity either based on the original farm measurement or on an approved means of measurement sited at the buyers receiving dock, such as a weighbridge or intake meter.

In 1986 approximately 37 000 milk producers with 40 000 farm vats produced a total of 12 700 million litres of ex farm milk during April 1985-March 1986. This milk was collected by an operational fleet of 1 710 vehicles, with approximately another 300 in operational reserve.

The sums of money involved are considerable, for example in 1985/86 the purchase of ex farm milk cost the MMB £2 000 million (pounds), therefore an improvement in accuracy of only 0.1 % is worth £2 million (pounds).

### 1.2 The role of the Milk Marketing Board's National Flowmeter (and Calibration) Centre (NFC)

During the 1970's the Board investigated the feasibility of using standard commercial measurement systems on ex farm vacuum tankers, but it was established that no commercial system was suitable and, due to the complexity and unique structure of milk as a fluid to be measured, the most feasible approach was to carry out the necessary development work within its own organisation.

In 1979 the Board's National Flowmeter Centre was built at Crudgington in the County of Shropshire, with suitable calibration and workshop facilities. In 1983, having carried out various evaluations on operational meter equipment, the Centre became the Board's kingpin for all the development and implementation of ex farm meter systems involving the software, electronic measuring control systems, turbine meter calibration, vehicle specification and field implementation.

All the metering equipment, designed to standards and specifications prepared by the Centre's staff, is manufactured by commercial companies to fixed quotations and delivery dates. The fitting and verification of the equipment on the tankers is carried out by commercial companies under the direct control of the Centre's own personnel.

## 2 Legislation and Tolerances

### 2.1 Legislation in England and Wales

As the current Weights & Measures legislation in England and Wales does not prescribe milk metering systems, pattern approval and initial verification are not required.

However, through both the EEC and the OIML, close attention is paid to all papers and directives which relate to the industry and also advances in metrology requirements. All transactions involving trade measurement are covered by the 1985 Weights & Measures Act.

### 2.2 Maximum Permissible Errors (MPE)

In order to establish the confidence of both the seller and the buyer and also to maintain " fair trade " the MPE decided on, in consultation with the Trading Standards Central Authority, was in line with those for other liquid measurements.

Summarized, these state : —

The limits of error for performance specification against an absolute reference volume are : —

a) On collections greater than 400 litres ± 0.5 %.

b) Collection of 200 litres and up to 400 litres inclusive ± 2.0 litres.

c) Between the minimum collection of 27 litres and up to 200 litres, a cumulative tolerance of ± 5.3 litres over seven consecutive collections (derived from statistical evaluation of the field trial results).

### 2.3 **The roles of the National Weights & Measures Laboratory and the Trading Standards**

The National Weights & Measures Laboratory administer the Weights and Measures Act, which includes pattern examination of measuring and weighing equipment. They also represent the Government and industry on the various International Metrology bodies within the EEC, OIML etc.

England and Wales are divided up, on a county or local authority basis, into many Trading Standards Authorities, currently numbering 120. The officers representing these authorities are responsible, among their many other roles, in ensuring that any transactions are "fair and just". They have the legal power to prosecute if their required standards or national standards are not observed. As the MMB intended to develop one type of measuring system to be used throughout the country, it was important to work through a central body representing all Trading Standards Authorities. This was achieved in conjunction with LACOTS (Local Authority Co-ordinating Body of Trading Standards) who, through their Technical and Metrology Panel, act on behalf of all the Trading Standards Authorities in England and Wales.

It should be noted that all the development work and the subsequent test and final implementation of the metering systems was carried out in complete liaison with LACOTS.

## 3 **Calibration Facilities used at the NFC**

### 3.1 **Calibration Rig** (Fig. 1)

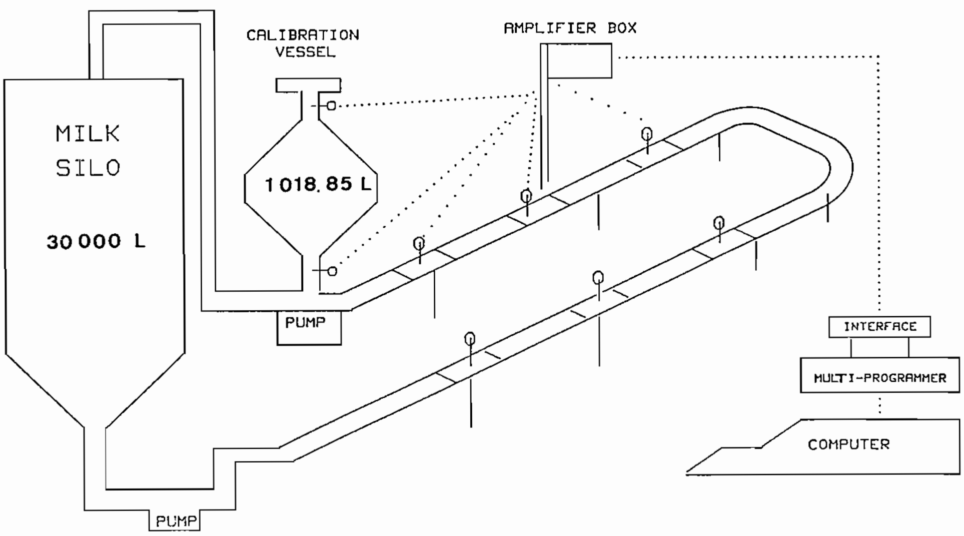


Fig. 1 — MMB National Flowmeter Centre calibration rig & control equipment

The NFC has two calibration rigs, each capable of calibrating simultaneously six meters. The calibration vessels, traceable to the standards of the NWML are of a nominal 1 000 litres and are supplied from 3 × 30 000 litres refrigerated silos. The accurate control of the fluid levels in the calibration vessels being monitored by probes linked to the electronic monitoring system. The flowrates are infinitely variable from 9 000 litres/hour to 42 000 litres/hour by the pumps being regulated by solid state speed controllers. In the original design flowrates were set by a flowrate control valve, but by experiment it was found the structure of the milk was changed so effecting calibration performance.

The whole calibration process is computer controlled analysing the results and plotting the calibration graphs.

We have now established a direct relationship between calibration performance on water and milk, so that all turbine meters, whether returned from the field for re-calibration or received from the manufacturer, are initially calibrated on water, and if successful then finally calibrated on milk.

All the turbine meters are 2 1/2" stainless steel units with the eight straight bladed rotors running on carbide steel shafts and bushes with the end thrust taken on ceramic balls. The design is such that each meter will produce 24/26 pulses per litre. The exact K factor (constant) is one of the functions of the calibration process.

### 3.2 **Calibration Criteria**

#### 3.2.1 Water Test

A turbine meter will be calibrated on milk if the water test reveals the following characteristics : —

a) Linearity — the turbine displays a frequency response such that the pulses generated per litre of water increases in proportion to an increasing flowrate. The result is a non-linear curve which must conform to a predicted pattern over a flowrange of 15 000 to 36 000 litres/hour.

b) Repeatability — over three test runs at any given flowrate, the difference between the greatest and least result should not be more than 0.05 % of the mean flowrate result.

#### 3.2.2 Milk Calibration

A turbine is issued for field use if the following criteria are satisfied : —

a) Linearity — the turbine is calibrated at intervals of flowrate over the range 15 000 l/h to 36 000 l/h, having three individual tests at each interval : —

15 000-25 000 L/h — the difference between the greatest and the least mean result should not be more than 0.1 % of the overall mean.

15 000-30 000 L/h — the difference between the greatest and least mean result should not be more than 0.125 % of the overall mean.

15 000-36 000 L/h — the difference between the greatest and least mean result should not be more than 0.2 % of the overall mean.

b) Repeatability — as in 3.2.1 (b).

#### 3.2.3 Bi-directional Trimming

All the MMB turbine meters are bi-directional with the pulses obtained at 36 × $10^3$ L/h (offload flowrate) in the reverse direction being the same as the pulses obtained at 25 × $10^3$ L/h (collection flowrate) in the forward direction. This is achieved by adjusting the reverse trim vane to either direct the milk flow towards or away from the rotor blade ; thus increasing or decreasing the speed of the rotor, in the reverse direction. The reverse calibration is carried out over the same flowrange as in the forward direction only at a reduced number of flowrates. This establishes whether or not the reverse linearity is acceptable should the offload flowrate fluctuate.

3.2.4 The graph in Fig. 2 illustrates the typical turbine calibration on both milk and water. These results can only be achieved by careful attention to blade and flow straightener design and especially the engineering finish.

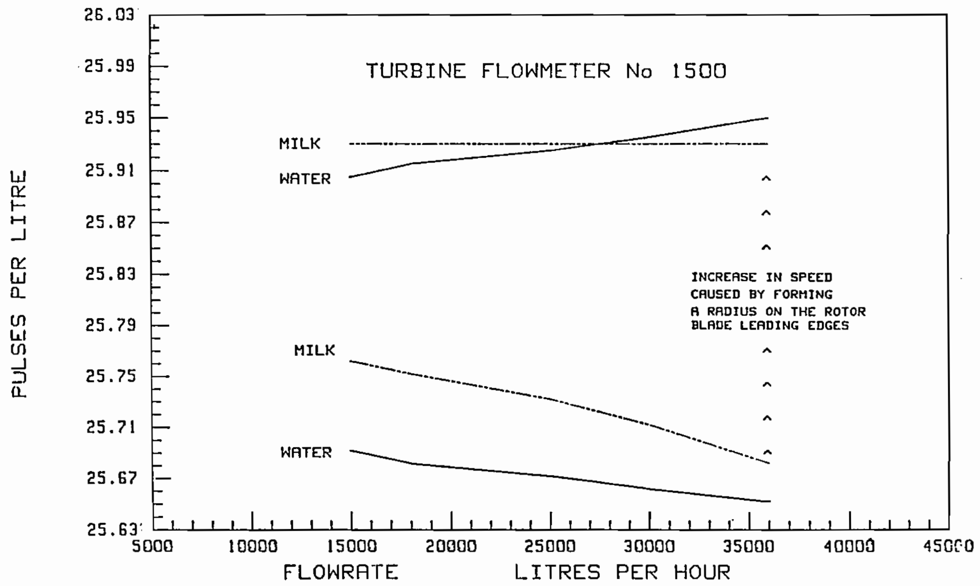


Fig. 2 — Milk/water relationship established at the MMB National Flowmeter Centre 1982-1985.

## 4 Development of the ex farm tanker flowmetering system

In the development of this system, of the many problems the five major ones were considered to be : —

a) In practically all other measurement concepts associated with vehicle metering systems, the objective is measuring a delivery. In the dairy industry we were faced with measuring collections of large or small quantities, from refrigerated vats on the regular basis of 40 000 collections/day.

b) The relationship of the collection vehicle to the vat varies considerably, ie the vat could be below or above the tanker and the tanker itself could be inclined both longitudinally and laterally.

c) Air entrainment due to the points raised in (a) and (b) and also accentuated by the use of the vehicle vacuum system.

d) The air elimination vessel and pipework were required to be completely emptied on completion of every collection/delivery.

e) The concept that the measuring instrument, the turbine meter, would be replaced with a re-calibrated unit from the NFC at regular intervals, currently 12 months. The changeover being achieved by "dialling in" the new meter's K factor into the electronic control system and not re-verifying the whole system.

### 4.1 The ex farm collection tanker

The MMB does not own or operate any ex farm tankers. All milk collection is contracted out to hauliers who must use vehicles built to a specification agreed with the MMB. Briefly this specification requires an insulated stainless steel vessel of either 9 000 litres or 14 000 litres with a vacuum operating between 300-450 mbar, automatically controlled by the vacuum pump driven by either an electric or hydraulic motor.

The electrical power, 24 V DC, for the system operation and the air pressure of seven bar for the operation of the three pneumatic valves, is taken from the vehicles own supply. The normal flowrate during collection varies from 22 to 32 000 L/h.

The rear of the tanker is designed so that a tanker operating on dipstick measurement can be converted to a flowmeter system in approximately four hours.

4.2 **The Metering System** (Fig. 3)

The metering system is completely automatic in operation, and after collection is completed, enables a printed receipt of the litreage collected at the farm to be left with the producer. The following is an overall description of the system, its use and method of operation.

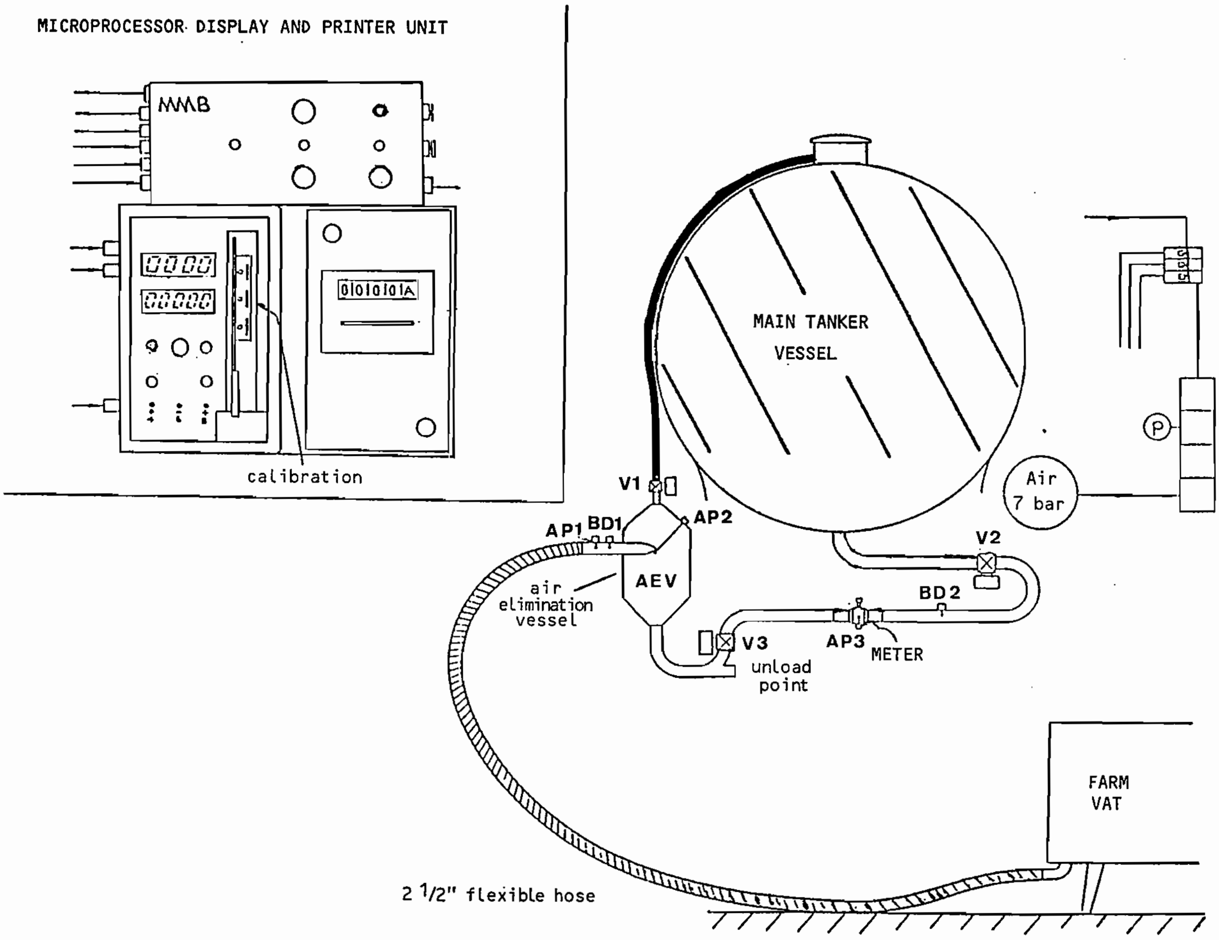


Fig. 3 — General layout of the metering system.
V1, V2, V3 — Air operated valves
AP1, AP2, AP3 — Milk detection probes
BD1, BD2 — Bubble detectors

The main components of the system are :

a) The stainless steel Air Elimination Vessel (AEV).
b) Various air operated butterfly valves.
c) A turbine meter and suitable transducer.
d) A digital display (LCD) of the individual farm measurements and the total aggregate collection.

e) A ticket printing device which enables a printed ticket for each collection to be kept at each farm and a copy to be retained by the haulier.
f) A microprocessor based system controller linked to the system by suitable probes and ensuring correct operation through individually selectable programmes for collection, unload and CIP (cleaning-in-place).
g) A power pack providing battery back up and electronic suppression of transients.

Milk collections (above 27 litres) can be split into four parts : —

i) Primary cycle - unmetered
ii) Main collection cycle - metered
iii) Line clearing cycle - unmetered
iv) Final clearing cycle - metered

This procedure ensures the best repeatability by standardising the measurement cycles. The driver, on arrival at the farm, will connect the tanker hose to the farm vat outlet, ensuring a tight connection, and remove the vat outlet bung. The operation of the flowmeter system is then as follows : —

i) Primary cycle

a) Driver ensures "system ready" light is on (AMBER)
b) Driver presses green button marked "collection"
c) "System ready" light off. "Collection running" light on (GREEN)
d) V1 opens to vacuum and milk is drawn into the AEV
e) AP1 and AP2 are monitored
f) On AP2 detecting milk, V1 will close
g) A short time delay to allow air/milk separation

ii) Main collection cycle

a) Microprocessor instructs V2 and V3 to open
b) Milk is pulled through turbine into the tanker and registered on totaliser display. GREEN "printer active" light on totaliser illuminates
c) AP2, BD1 and BD2 are monitored by the microprocessor
d) Near the end of collection level of milk in AEV drops below AP2 causing V2 and V3 to close

iii) Line clearing cycle (or scavenge)

a) V1 opens to vacuum
b) AP1 and AP2 are monitored by the microprocessor
c) The remaining milk in the hose is pulled into the AEV
d) If AP1 remains dry for 4 seconds then V1 closes. If AP2 goes wet the programme will return to the main collection
e) Short time delay to allow air/milk separation

iv) Final clearing cycle

a) V2 and V3 open
b) Remaining milk is pulled through turbine meter and registered on totaliser display
c) Probe AP3 in the turbine is monitored by the microprocessor until it has gone dry for 3 seconds
d) V2 and V3 will then close
e) "Collection running" light off (GREEN). "System ready" light on (AMBER)

The system has now returned to the readiness mode and the vat is empty !

On completion of the collection, the driver places a ticket in the printer and presses the print button. The litreage and status flag are printed on the ticket. Once the print action is completed the " Printer " light switches off. After 20 seconds the totaliser vat litreage display resets to zero. The flag for a normal collection is " M ", which indicates that the collection was completed satisfactorily.

The hose can now be disconnected from the farm vat and stowed on the tanker.

In other cases the flag (or symbol) printed on the ticket has the following meanings :

" L " indicates entrained air was detected before the meter by bubble detector BD1. The milk collection is valid, but this information may be required to aid any investigation that may be considered necessary under the code of practice.

" A " indicates that entrained air was detected after the meter by bubble detector BD2. The milk collection receipt would be considered invalid and would not be left at the farm.

" E " indicates that the driver, for procedure or technical reasons, used the system over-ride to complete the milk collection. The milk collection receipt would be considered invalid and would not be left at the farm.

" F " would indicate to the creamery/dairy that the ticket was either produced when unloading the vehicle *or* when clearing the system after cleaning-in-place. Due to the incorrect operation by the driver, in the unlikely event of such a flag ticket being produced on the farm, the milk collection receipt would be considered invalid and not be left at the farm.

MILK MARKETING BOARD

Unfortunately NO MEASUREMENT of your milk was possible today. You will shortly be receiving a letter advising you of the estimated LITREAGE.

The above printed statement on the ticket will be left with the producer indicating that there was no measurement by flowmeter due to the advent of a measurement ticket flagged with an A, E or F.

v) Unloading and cleaning (CIP)

The unloading is carried out by the use of the suitable software programme, the hose being transferred to the unloading point and connected to a pump. The pressing of the unload button opens V2 and V3 after the tanker has been vented to atmosphere by the driver.

For the tanker to be cleaned the creamery cleaning-in-place (CIP) system is connected to the tanker via the vacuum pipework. Within the AEV a sprayball is permanently fixed. Through the systems software programme the interior of the AEV is " pulsed " throughout the CIP cycle through V1. The main tank cleaning is through a removable sprayball, with the cleaning fluid drawn out from the tanker through V2 and V3.

### 4.3 **Test methods agreed with LACOTS**

It was agreed that these tests would be divided into two parts, the first part in the Laboratory at the National Flowmeter Centre premises, and the second part at farm trials encompassing actual ex farm milk collections.

Laboratory measurements were based on three proving vessels of nominal 45, 240 and 480 litre capacity, the precise capacity of each having been determined by the National Weights and Measures Laboratory.

The laboratory tests were designed to test the capabilities of the system under ideal conditions and describe the performance in terms of accuracy and repeatability. Once established, the effects on accuracy and repeatability were observed when the system was subjected to a range of conditions, covering the physical extremes of operating conditions with various attempts to influence the measurement by deliberate fraudulent means.

Tests undertaken in the laboratory included over twenty main objectives with obviously air elimination, air entrainment control, interchangeability of the turbine meter and other main components being some of the main objectives.

During the course of the tests comprehensive notes were made of all situations which affected the operation of the system. If system rectification was required when this was completed the tests would be repeated and the results re-analysed.

An example of the format of the lab test recording and analysis are shown in Fig. 4 and 5.

During the series of variable tests, a control run under standard conditions was initially made and hence the affect of the introduction of known error, or possible adverse conditions, could be measured. The "Result Sheet" (Fig. 4) contains all relevant details of one such control run. For these tests both whole numbers of litres (vat litres) and litres to the nearest tenth of a litre (printed litres) were recorded by the metering system. Differences between the metered litres and the total test volume were calculated and expressed as percentages of the reference volume — in this example 238 895 litres.

A basic statistical analysis of the test results was made for each test and summarised on the "Summary of Test Results" sheet (Fig. 5). The Vat Print data section refers to the metered volume to the nearest tenth of a litre and the Vat data to the whole number of litres, the measurement made in practice on farm collections. All calculated statistics were expressed in both litres and percentages.

As all these laboratory tests were concluded satisfactorily, the field testing of the updated system was undertaken.

For the field trials 10 ex farm vehicles were equipped with the metering system. To establish the necessary field control, the producers vats on various collection routes were calibrated by Trading Standards Officers, using a flowmeter supplied and calibrated by the Warwickshire County Council Calibration Centre and proved at the NFC. During each farm vat re-calibration, after each increment had been deposited by the flowmeter into the vat, the depth to the surface of the liquid was taken from standard datum points by a point gauge. These direct measurements were then projected onto a computer base to provide individual calibration details for each vat in terms of litres at measurement increments of 0.5 mm.

The 10 vehicles delivered into two buyers, each buyer operating a weighbridge installation previously verified to ± 5 kg. The information from the results of producers collections by conventional dipping, Trading Standards point gauges and meter readings were compared and analysed. The totals for the loads were compared with the weighbridge results and also analysed using the standard milk density of 1.0327. Such comparisons facilitated a valid basis on which to ascertain the performance of the system by statistical evaluation over the 25 day period of the trial.

At the conclusion of these tests all results were correlated, the appropriate comparisons made, and an extensive report prepared for the consideration of LACOTS metrology panel. After considering this report, LACOTS Metrology Panel granted formal approval in August 1984 for the system to be used for the measurement of milk collected from farms in England and Wales, with the proviso that it must only be operated in accordance with a Code of Practice agreed with all interested parties, formally approved by LACOTS and effectively enforced within the industry. The Trading Standards Authorities were to have an overseeing role, and also be available to all parties in the event of disputes and measurement queries.

| | |
|---|---|
| RESULT SHEET NO: | 1 |
| DATE | 25.11.83 |
| METER REFERENCE | 2036 2 |
| METER FACTOR | 3849 |
| P.C.B NO. | 5/1577/6 |
| P.C.B FACTOR | 849 |
| VEHICLE | HPF 762 V |
| OBJECT | CONTROL RUN |

REFERENCE NO: 8

| | | | |
|---|---|---|---|
| TEST VOLUME | | = | 240 |
| COMPRISING | x 500.393 | = | |
| 1 | x 238.895 | = | 238.895 |
| | x 45.3935 | = | |
| TOTAL TEST VOLUME | | = | 238.895 |

| RUN NO. | MILK TEMP °C | AMB TEMP °C | VACUUM START | D1 | D2 | ROUTE (Litres) | VAT (Litres) | PRINTED (Litres) | ERROR VAT (Litres) | ERROR VAT % | ERROR PRINT (Litres) | ERROR PRINT % | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0000 | | | | | | | |
| 1 | 6.5 | 17.5 | | | | 239 | 239 | 238.8 | +.1 | +.044 | +.095 | -.040 | |
| 2 | | | | | | 478 | 239 | 239.2 | +.1 | +.044 | +.305 | +.128 | |
| 3 | | | | | | 717 | 239 | 238.6 | +.1 | +.044 | -.295 | -.123 | |
| 4 | | | | | | 956 | 239 | 239.1 | +.1 | +.044 | +.205 | +.086 | |
| 5 | | | | | | 1195 | 239 | 239.0 | +.1 | +.044 | +.105 | +.044 | E.A.D. Shut down. |
| 6 | | | | | | 1434 | 239 | 239.0 | +.1 | +.044 | +.105 | +.044 | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

COMMENTS Standard runs

Fig. 4 — Test result sheet

| | | |
|---|---|---|
| DATE OF TEST | : | 25/11/83 |
| REFERENCE NUMBER | : | 8 |
| REFERENCE VOLUME | : | 238.895 litres |
| TEST CONDITIONS | : | Control run |
| **VAT PRINT DATA** | | |
| SAMPLE SIZE | = | 6 |
| MEAN ERROR | = | +0.06 (+0.02%) |
| STANDARD DEVIATION | = | 0.22 (0.09%) |
| MAXIMUM | = | +0.31 (+0.13%) |
| MINIMUM | = | -0.30 (-0.12%) |
| RANGE | = | 0.60 (0.25%) |
| TOLERANCE | = | ± 2 litres |
| No. OUTSIDE TOLERANCE | = | 0 |
| **VAT DATA** | | |
| MAXIMUM | = | +0.1 (+0.04%) |
| MINIMUM | = | +0.1 (+0.04%) |
| RANGE | = | 0.0 (0.00%) |
| No. OUTSIDE TOLERANCE | = | 0 |

COMMENTS

Calculations using all data.

Fig. 5 — Summary of test results

## 5 System Protection

### 5.1 Environmental

Any mechanism, whether electronic or mechanical, obviously benefits from protection from the elements. It should also be noted that when drivers wash down the vehicle, either by pressure hose or bucket and broom, this gives a totally different set of conditions.

In the evaluation of the MMB meter systems their ability to operate in the weather conditions met throughout the year, ie sun, rain and snow, was paramount. The electronic system is housed at the rear of the tanker within an aluminium box compartment, also used to carry producer samples.

Special tests undertaken covered the operational functions of the pneumatically operated butterfly valves down to — 12 °C and on the electronic counting and control system, down to — 20 °C.

### 5.2 Methods of system protection from fraud and driver safeguards

It is of course very dependant on current legislation applicable in a country using measuring systems as to the level of system protection employed.

In England and Wales the approach was threefold : —

a) Electronic control resulting in ticket status flagging which would be used by management to control fraud and incorrect use.

b) Inclusive of software routines to ensure the system operation was correct.

c) Manual sealing of certain connections to prevent tampering.

The above criteria was achieved by the following means : —

#### 5.2.1 Bubble Detector BD1

Bubble Detector BD1 is located near the inlet to the AEV and is monitored in the " main collection ". Bubble Detectors operate by monitoring the number of bubbles continuously over two second intervals. When entrained air is detected V3 closes and a pulsed single tone alarm sounds for five seconds, after which V3 re-opens and collection continues.

If the air leak is not located and sealed, the collection will stop/start throughout the main collection. A status flag of " L " will be printed on the ticket if BD1 activates more than twice.

#### 5.2.2 Bubble Detector BD2

Bubble Detector BD2 is located downstream of the turbine and will detect entrained air introduced between the AEV and turbine meter, or large air leaks which cannot be controlled by BD1 action.

When BD2 detects air it will close V3 and sound a continuous single tone alarm. The alarm stops after five seconds and V3 re-opens.

Once BD2 has activated the collection will be considered invalid and no further shutdowns will occur for this collection. A flag of " A " will be printed as BD2 activates.

5.2.3 No milk safeguard

If the tanker operator forgets to connect his hose or fails to take out the vat bung, then on pressing button marked " collection ", V1 will open for approximately five seconds, then close. " System ready " light will come on.

5.2.4 Printer inhibit

A ticket cannot be printed until the controller goes to " system ready ". This also includes inhibit if AP2 or AP3 are wet (indicated by the illumination of either Amber and Green LED).

5.2.5 Emergency Stop/Over-ride

This shall only be used if the system malfunctions. If used the ticket will be flagged with an " E ".

5.2.6 Back-up Battery

A back-up battery will maintain the system for up to two collections should the main voltage source malfunction.

This is indicated by the power light red LED flashing.

5.2.7 Collection Start Inhibit

If milk has passed through the turbine causing litres to be registered on the totaliser display, then a ticket must be printed before the collection button can be activated.

If milk or CIP water is left in the system, so activating AP2 or AP3, then the system LED, both amber and green, will be illuminated and the collection start will be inhibited until corrective action is taken by the driver.

5.2.8 Operational Security

Once a software programme has been initiated by means of one of the buttons on the controller, then all the other programmes are inhibited.

5.2.9 Driver Aids

At the end of the collection or whenever system returns to start, an audible " bleep " will be sounded to indicate end of collection or indicate a return to start (such as would occur if bung has not been removed from vat).

5.2.10 Flagging

All tickets printed by the system are printed with a status " flag " which is be used by management in controlling the milk collection process. A summary of the code letters printed on tickets and their meaning are detailed above in section 4.2.

Tickets marked with an A or E would not be handed to the producer. A ticket endorsed " No measurement " would be issued instead. An assessment of the quantity will be made by the use of a four day average, two days would be taken before the void collection and two days after. A mean would then be taken of the four days.

5.2.11 Sealing

Connections for inferential meter clamps, reverse trimming vane, front cover of the meter system, BD1 and BD2 are sealed by copper wire and lead seals. If broken the reasons must be stated in the Transport Depot's records and re-sealed.

The electronic system is designed and tested to be unaffected by the transient voltage " spikes " experienced in vehicle power supply, magnetic influences and radios.

## 6 Code of Practice and training

In any system the equipment is always dependant on people — the managers, drivers, producers, fitters, etc. Therefore LACOTS considered a Code of Practice (CoP) must be prepared and agreed with representatives of all interested parties, such as the Buyers, MMB, Trading Standards, Farmers Union etc. This was done and introduced in conjunction with the metering systems.

It is beyond the scope of this paper to describe the CoP, but without a reference document of this type, along with the correct training of all users, the successful introduction of such technology would be difficult and in some areas impossible.

## 7 Statistical results from operational evaluation

The MMB to date has now converted 360 ex farm collection vehicles from dip measurement to the metering system.

Following the introduction of the metering system on 290 vehicles, the MMB, the Dairy Trade Federation (DTF) and LACOTS set up a joint technical working party to ensure the operational results of the metering systems confirmed the initial development work.

This evaluation commenced in August 1985 and was completed in October 1986, involving 14 hauliers operating 219 vehicles, collecting from 3 500 producers and delivering into 31 buyers. Buyers weighbridges verified to ± 5 kg were used as a comparison for the results obtained during the farm collections.

Unfortunately, space available for this paper does not allow coverage of the many facts produced in the final 65 page report. It is sufficient to say that from 622 000 individual farm collections, 570 million litres of milk were collected. The difference between the weighbridges and the meters was only 48 000 litres or + 0.01 %. When compared to the 0.2 % differential expected under dip measurement, related to weighbridges, the resulting improvement in accuracy and the possible cost saving of up to £4 million (pounds) per annum is considerable. There are many other benefits, from automated collections to the large reduction in individual load differences, also there is no doubt that both the Trade, producers, Trading Standards and the MMB benefit from the introduction of a practical accurate measuring system designed for a specific industrial requirement.

## 8 The Future

The MMB will continue its programme to install milk measuring systems on ex farm vacuum tankers. However modern technology is always producing new concepts or in many cases enabling old ideas to become viable with new technology.

The NFC is currently evaluating designs for data capture equipment on tankers, with the electronic control and recording systems becoming very much more software orientated. Looking at the actual metering equipment, with the much more reliable electromagnetic flowmeters now coming on to the market, NFC have been evaluating various types with some very encouraging results.

Figures 6 and 7 indicate the calibration performance of a typical 2 ½" electromagnetic flowmeter, though the path from development to an operational system in such a demanding industry as ours will again require thorough practical evaluation procedures.

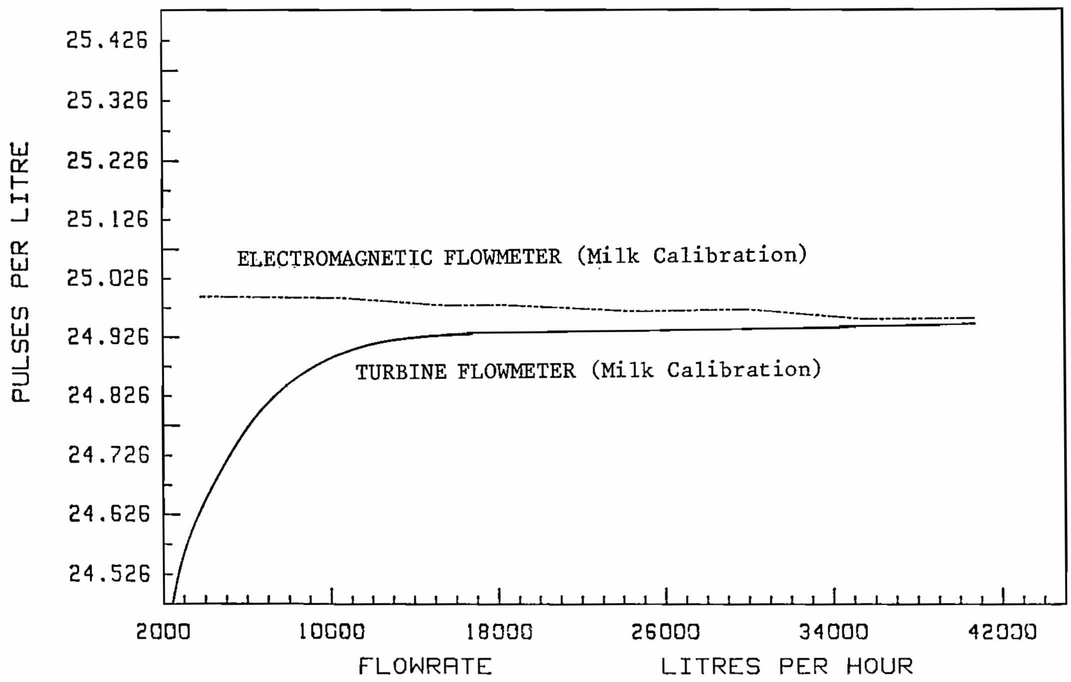


Fig. 6 — Comparison between the linear range of an electromagnetic and a turbine flowmeter

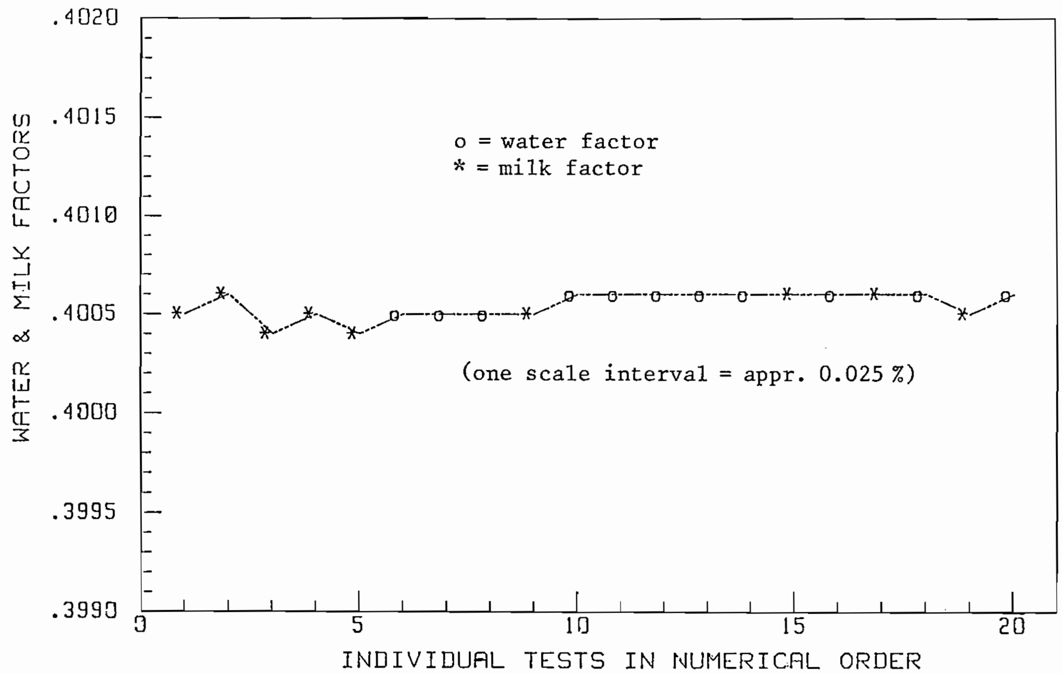


Fig. 7 — Variation in K-factor for an electromagnetic flowmeter when calibrated on water or milk

## 9 Conclusion

This paper has provided a review of the techniques and policies undertaken in the practical implementation of measuring systems on ex farm tankers, together with the considerable benefits to the industry overall.

It also reflects on what can be achieved when the enforcement authority, in our case the Trading Standards, works closely with the industries representatives as a technical team, in solving, in a practical way, both the measurement difficulties and the implementation problems inherent in any technological change.

The success of the measuring systems implementation would not have been possible without the wholehearted co-operation of all sections of this Industry, especially the hauliers and buyers in preparing and recording the large amount of operational information for subsequent statistical analysis.

# The EFFECTS of a CHANGE of LOADING CYCLE PARAMETERS in HARDNESS TESTING *

**Ferenc PETIK**

### Introduction

The definition of hardness testing methods prescribes a loading cycle with fixed values for forces, load application times, and indenter velocities. The loading cycle for the Rockwell test can be illustrated by the graph in Fig. 1.

The problem to be discussed here is the following. In high-precision hardness testing, including the calibration of test blocks, the general practice has been to employ a loading cycle different from that used in industrial hardness testing. To ensure completely stabilized conditions in calibration the force was increased less rapidly and the test force was maintained for a longer time than is now proposed. Industry cannot afford such long waiting periods : it is its very rapidity that gives hardness testing its popularity.

In the new ISO Standards (ISO 6508-1986 Metallic materials — Hardness test — Rockwell test and ISO 674-1988 Metallic materials — Hardness test — Calibration of standardized blocks to be used for Rockwell hardness testing machines) the loading cycles are identical for both standardization and industrial testing. The basic motivation of this deserves respect at first glance ; it is the wish to perform tests under identical conditions both in the field and in the metrological laboratory. The metrological consequences, however, are grave : a shift of national and international hardness reference scales (systematic error) and increased uncertainty of measurements (random error).

### Elements of the loading cycle

In the present considerations we are especially concerned with the following elements of the loading cycle :

$t_o$, time of application of the preliminary test force

$t_i$, load rise time from preliminary test force to total test force

$t_m$, time of application of the total test force.

The values given in the old and new ISO specifications for the calibration of standardized blocks for Rockwell hardness testing machines are shown in Table 1.

TABLE 1

Values specified in the Standards

| | ISO/R 674 (1968) | ISO 674 (1988) |
|---|---|---|
| $t_o$ | 10 to 20 s | 1 to 10 s |
| $t_i$ | — | 2 to 8 s |
| $t_m$ | 30 to 35 s | 3 to 5 s |

* Paper presented at the IMEKO TC 5 Symposium "Accurate measurement and metrology of hardness" at Prague, Czechoslovakia, 7 June 1988.

The views expressed by the author should not be considered as the official opinion of OIML.

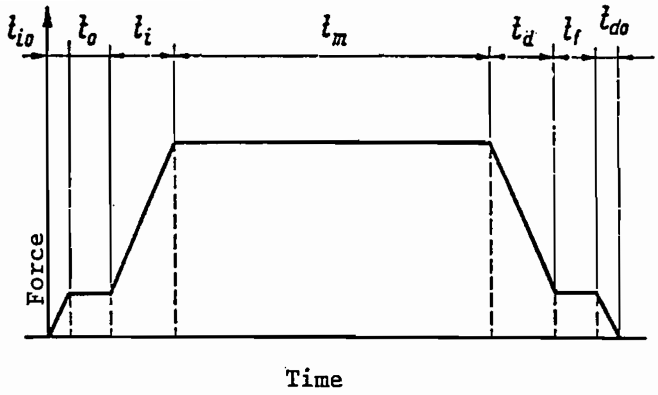


Fig. 1 — Graph of the loading cycle for Rockwell hardness measurements

**Time of application of the preliminary test force** ($t_o$)

The former practice was to maintain the preliminary force for 10 to 20 s, because approximately 10 s was necessary to stabilize the position of the indenter. The new prescription is 1 to 10 s. DAMBACHER [2] found a difference of 0.3 to 0.4 HRC in the final hardness value of a block of 20 HRC, depending on whether the preliminary test force was maintained for 1 s or 10 s. This tolerance range for time, in the unstabilized part of the indentation cycle is very wide. The freedom given to the person doing the test to select the duration of the preliminary force results in an increase in random uncertainty.

**Load rise time** ($t_i$)

ISO 674 specifies a load rise time of 2 to 8 s for a-type machines, and an indentation velocity of 5 to 20 μm/s for b-type machines. The effect of the velocity range specified for b-type machines can be estimated from the experimental results published by YAMAMOTO (Fig. 2) [3], WEILER (Fig. 3) [4,5], and MARRINER (Fig. 4) [6] to be about 0.1 to 0.3 HRC.

The load rise time of 2 to 8 s specified for a-type machines corresponds to the following velocities :

12 to 25 μm/s at 65 HRC
22 to 90 μm/s at 20 HRC.

This indicates another problem : these ranges cover only partially the range of velocities specified for b-type machines at high hardness levels, and do not cover any of the range at low hardness levels.

The effect of the ranges given here is 0.2 to 0.3 HRC at 65 HRC, and 0.2 HRC at 20 HRC, again according to the researchers previously cited. This is another cause of newly introduced uncertainty.

**Time of application of the total test force** ($t_m$)

The value specified earlier was 30 to 35 s, and has now become 3 to 5 s. The reason given for the change is to approach more closely the conditions of industrial hardness testing. But the Standard ISO 6508-1986 for ordinary hardness testers gives three different times of application, namely.

1 to 3 s for materials with no time-dependent plasticity,

1 to 5 s for materials with some time dependent plasticity,

10 to 15 s for materials with considerable time dependent plasticity.

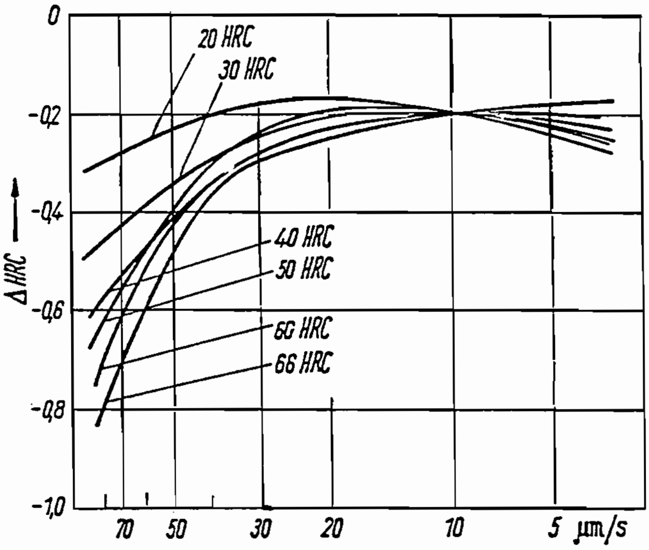


Fig.2 — Hardness value as a function of indentation velocity [3]

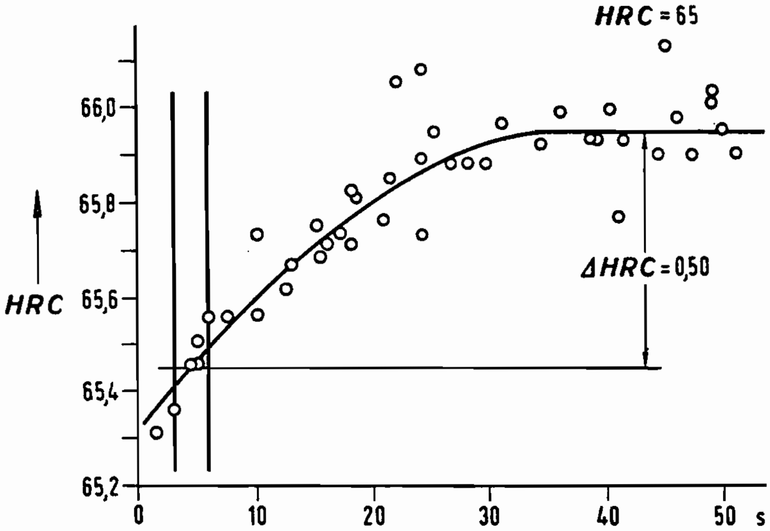


Fig. 3 — Hardness value as a function of load rise time [4, 5]

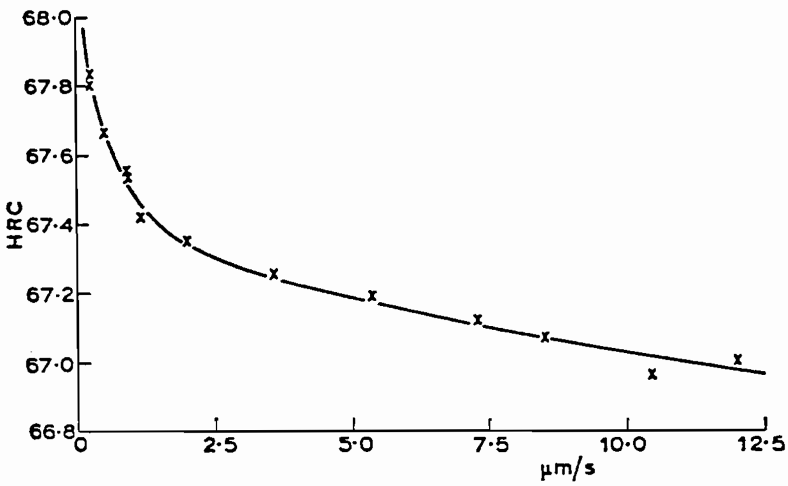


Fig. 4. — Hardness value as a function of indentation velocity [6]

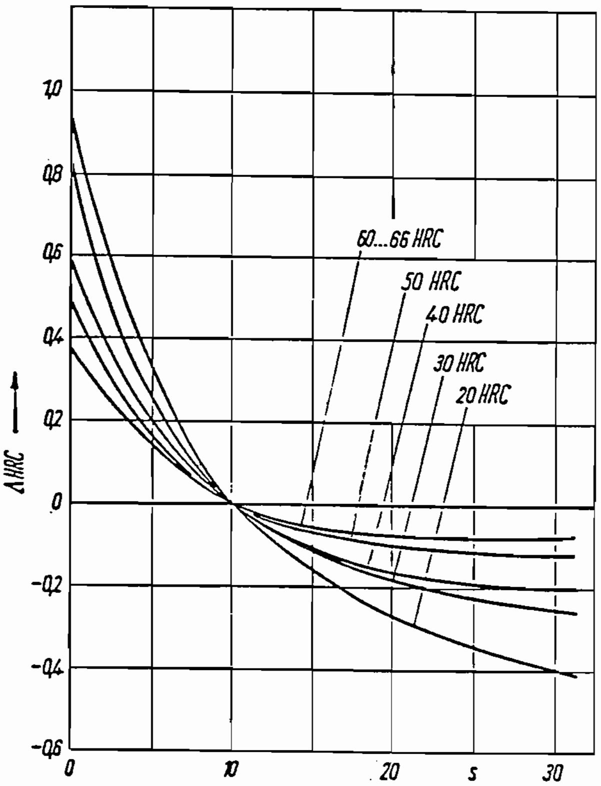


Fig. 5 — Hardness value as a function of the time of application of the total test force [3]

The delimitation of the three degrees of plasticity is very vague. The value specified for the calibration of blocks (3 to 5 s) is set somewhat arbitrarily amid the above-indicated time ranges, the application of which is not well defined.

The effects on the standardized hardness value are multiple, resulting in both random and systematic errors.

The result of a hardness test is different according to whether the time of application is 3 or 5 s. The curves (Fig. 5) published by YAMAMOTO [3] clearly show that a shorter time means a greater result. The effect is greater on materials of low hardness (considerable time dependent plasticity). The diagram shows that stabilization of penetration is not to be expected before 30 s. At 3 s or 5 s the curves are very steep. The difference of hardness values obtained with the two limiting values of the specified time (3 s and 5 s) is

0.1 to 0.2 HRC at 20 HRC

0.1 HRC at 60 HRC.

Similar results were obtained by several other research workers (see Figures 14 to 16 in [1]). This is another uncertainty caused by the specified range for time.

TABLE 2

Hardness values (HRC) obtained with a duration of

| 30 s | 5 s | 3 s |
|---|---|---|
| 20.0 | 20.6 to 20.7 | 20.7 to 20.9 |
| 60.0 | 60.2 | 60.3 |

More important is the systematic error introduced by reducing the time of application from 30 to 35 s to 3 to 5 s (Table 2). This means that the national hardness reference scales maintained by the metrological institutions should be corrected by up to 0.9 HRC at the low end and by 0.3 HRC at the high end of the HRC-scale. This modification of the reference scale would be similar to the effect of the proposal to introduce rounded force values expressed in newton (1 471 N rounded to 1.5 kN), which was rejected a decade ago.

In [2] a measurement on the Rockwell-B scale is also mentioned (Table 3).

TABLE 3

Hardness values (HRB) obtained with a duration of

| 15 s | 5 s | 3 s |
|---|---|---|
| 55.0 | 56.1 | 56.8 |

**Addition of uncertainties resulting from the range of time specifications**

Three kinds of uncertainties, originating from the specified ranges of time have been mentioned (Table 4).

The resulting uncertainty can be considered in two ways :

a) Let us assume, firstly, that time values within the specified ranges will be employed by test personnel at random. In this case a standard deviation can be estimated from the sum by quadratic addition, by using the appropriate formula. The three specified time ranges result in an increase in the uncertainty of the hardness standardizing machine by 0.4 HRC. The propagation of this uncertainty can be calculated according to [7].

b) We may assume, alternatively, that the relatively wide tolerance ranges for time are the result of a compromise, aimed to satisfy different national prescriptions simultaneously. In this case a given national standardizing institute will use only a narrow part of the ranges specified in the Standard. But these will not necessarily be identical to those used by other national institutes. The result will be a systematic difference between the calibrated values obtained by different institutes which may be as great as the arithmetic sum indicated in Table 4, namely 0.7 HRC. The international uniformity of hardness measurements is thus impaired.

TABLE 4

Range of hardness values (in HRC)

| resulting from the range of time specified for | at hardness level 20 HRC | 60 HRC |
|---|---|---|
| $t_o$ | 0.3 to 0.4 | 0.2 |
| $t_i$ | 0.2 | 0.2 to 0.3 |
| $t_m$ | 0.1 to 0.2 | 0.1 |
| Sum by simple addition | 0.7 | 0.6 |
| Sum by quadratic addition | 0.4 | 0.4 |

**The reasoning underlying the new specifications**

The specialists proposing the changes in the loading cycle argued as follows : the blocks are first tested on a standardizing machine, later on commercial hardness testers. It is reasonable that both tests be carried out under identical conditions.

At first glance this statement seems to be attractive. But what would these same persons say if the metrological laboratory defining the meter (now defined from the velocity of light) were obliged to use the same procedures as a machine operator using a slide calliper to determine the diameter of a piece being machined ?

The respective roles of measurement standards and of ordinary measuring instruments should be clearly distinguished. The measurement standard defines the unit of measurement or produces a scale of measurement. The ordinary measuring instrument reproduces the scale of measurement defined by the standard. The ordinary measuring instrument must be traceable to the standard ; it should reproduce the values of the standard, though of course not with the same uncertainty. The standard should be built with the lowest uncertainty technologically possible. Therefore the metrological methods employed when using a standard may be very elaborate, time consuming and costly.

The hardness standardizing machine is a measurement standard maintaining the national hardness reference scale. All the conditions necessary to ensure low uncertainty when defining the measurement scale, such as, among others, sufficient time, should be satisfied. The hardness values defined by the standardizing machine are thereafter transferred through the agency of blocks to the commercial hardness testers. These should be adjusted to give hardness consistent with those of the blocks. This method ensures the traceability of industrial hardness measurement to national standards, i.e. national hardness reference scales. But the commercial hardness testers are not intended or qualified for defining the hardness values ; they should only reproduce the values of the standard. Therefore it is not necessary that the test cycle of the commercial hardness tester be identical to that used on the standardizing machine.

This basic metrological principle of the traceability of measuring instruments was not followed when developing the new standard prescriptions. The consequence is an increase in the uncertainty of the hardness values of the blocks, and the necessity to modify, that is to shift the national hardness reference scales.

The ISO Standards discussed here are either already published or are ready for publishing, so the above considerations can be taken into account only at the next revision.

**References**


[1] Factors influencing hardness measurement. BIML, Paris, 1983.

[2] ISO/TC 164/SC 3 N 426. Comments of Germany F.R.

[3] Yamamoto, K., Yano, H. : Standardization and international comparison of Rockwell C scale. Bulletin of the NRLM, Oct. 1966. (In German : Feingerätetechnik 15 (1966), 507-513).

[4] Weiler, W. : Ein Beitrag zur Abhängigkeit der Rockwell-Härte von der Zeit der Lastaufbringung. VDI-Berichte 100, Düsseldorf 1967, 123-126.

[5] Weiler, W. : Der Einfluss der Zeit der Lastaufbringung auf das Ergebnis der Härtemessung nach Rockwell-C. PTB-Mitteilungen 75 (1965), 328-330.

[6] Marriner, R.S. : The precision and accuracy of the hardness tests. ACTA IMEKO, Stockholm 1964, UK 245.

[7] Petik, F. : Statement of uncertainties at hardness testing. VDI-Berichte 583, Düsseldorf 1986, 41-62.

## SEMINAIRE SUR LA PLANIFICATION ET L'EQUIPEMENT DE LABORATOIRES DE METROLOGIE ET D'ESSAIS

**Paris, 25-26 Septembre 1989**

Ce séminaire a pour but de donner des conseils sur la conception et les installations de laboratoires de métrologie légale et industrielle éventuellement associée aux essais officiels ou par accréditation des produits mécaniques et électriques. L'accent sera mis sur des réalisations économiques et efficaces.

Le séminaire est organisé dans le cadre des travaux du Conseil de Développement de l'OIML et il est ouvert à des délégués des Etats Membres et Membres Correspondants de l'OIML ainsi qu'à des institutions et conférenciers spécialement invités.

Langues : Français et anglais (traduction simultanée).

Les sujets suivants seront traités :

1. Exigences fonctionnelles basées sur l'étendue et les relations entre les différentes activités et autres aspects pratiques
2. Conception des bâtiments
3. Choix des systèmes d'air conditionné, distribution d'électricité, d'eau et autres installations
4. Conception et équipement de base des unités de laboratoires de
   - masse
   - volume
   - métrologie dimensionnelle
   - force et pression
   - température
   - électricité
5. Tour d'horizon des exigences pour les laboratoires d'essais mécaniques et électriques en rapport avec la métrologie
6. Conception du mobilier de laboratoire.

Le programme définitif sera fixé en fonction de la disponibilité des conférenciers spécialisés et sera communiqué plus tard directement aux participants enregistrés, en même temps que l'adresse de la salle de conférence.

Il est prévu qu'une brève réunion du Conseil de Développement de l'OIML aura lieu en liaison avec le séminaire.

Nous vous prions de bien vouloir envoyer les noms et adresses des délégués de votre pays au BIML avant le 1er MAI 1989.

## SEMINAR ON PLANNING AND EQUIPPING METROLOGY AND TESTING LABORATORIES

**Paris, 25-26 September 1989**

Scope : The seminar intends to give advice on how to design and equip laboratories for legal and industrial metrology associated where applicable with official or accredited testing of mechanical and electrical products. Special emphasis will be put on low-cost and cost-efficient facilities.

The seminar is organized within the framework of the OIML Development Council and is open to delegates from OIML Member and Corresponding Member Countries as well as to specially invited institutions and speakers.

Languages : French and English (simultaneous translation).

The following subjects are intended to be dealt with :

1. Functional requirements based on the extent and interrelations of activities and other practical aspects
2. Lay-out of buildings
3. Choice and design of air-conditionning systems, electrical, water and other supplies
4. Lay-out and main equipment of the metrology laboratory units for
   - Mass
   - Volume
   - Dimensional metrology
   - Force and pressure
   - Temperature
   - Electricity
5. Survey of laboratory requirements for metrology related testing of mechanical and electrical products
6. Laboratory furnishing.

The final programme will depend on the availability of specialist speakers and will be communicated later directly to the registred participants, as well as the place of venue.

It is planned that a short meeting of the OIML Development Council will take place in connection with the seminar.

Please send the names and addresses of the seminar participants planned to be delegated from your country to BIML before 1st MAY 1989.

## REUNIONS OIML

| | Groupes de travail | Dates | Lieux |
|---|---|---|---|
| SP 5D - Sr 10 | Mesurage massique direct en dynamique des quantités de liquides | 5-6 avril 1989 | TEDDINGTON ROYAUME-UNI |
| SP 8 | Poids | 7 avril 1989 | TEDDINGTON ROYAUME-UNI |
| SP 7 - Sr 5 | Instruments de pesage à fonctionnement automatique | 10-14 avril 1989 | TEDDINGTON ROYAUME-UNI |
| SP 17 et ses Secrétariats-rapporteurs | Mesure des pollutions | 17-21 avril 1989 *(provisoire)* | BERLIN-OUEST |
| SP 26 - Sr 4 | Instruments de mesure bio-électriques | 24-29 avril 1989 | KRASNODAR URSS |
| SP 5D - Sr 1 | Compteurs et ensembles de mesure de liquides autres que l'eau à chambres mesureuses ou à turbine | avril 1989 *(provisoire)* | PARIS FRANCE |
| SP 5D - Sr 6 | Dispositifs électroniques appliqués à la mesure des volumes de liquides | avril 1989 *(provisoire)* | PARIS FRANCE |
| SP 30 - Sr 13 | Ethylomètres | 9-12 mai 1989 *(provisoire)* | PARIS FRANCE |
| SP 30 et SP 30 - Sr 1, Sr 2, Sr 4, Sr 6, Sr 9, Sr 10, Sr 12, Sr 13 | Mesures physico-chimiques | 22-27 mai 1989 | TBILISSI URSS |
| SP 5D - Sr 8 | Compteurs électromagnétiques | août/sept. 1989 *(provisoire)* | BRAUNSCHWEIG R.F. D'ALLEMAGNE |

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| | Dates | Lieux |
|---|---|---|
| Conseil de la Présidence | 13-14 avril 1989 | BIML PARIS |
| Séminaire sur la planification et l'équipement de laboratoires de métrologie et d'essai + Conseil de Développement | 25-26 sept. 1989 | PARIS FRANCE |
| 24e Réunion du CIML | 27-29 sept. 1989 | PARIS FRANCE |

Note : Cette liste a été établie le 15 janvier 1989 et peut ne plus être à jour.
*This list was established 15th January 1989 and may no longer be up to date.*

## 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*

R Nº

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 — Voir R 76
*See R 76*

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 (sphygmomanomètres)
*Manometers for instruments for measuring blood pressure (sphygmomanometers)*

17 — Manomètres, vacuomètres, manovacuomètres 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, manovacuomètres 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 — Voir R 76
*See R 76*

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

71 — Réservoirs de stockage fixes. Prescriptions générales
*Fixed storage tanks. General requirements*

72 — Compteurs d'eau destinés au mesurage de l'eau chaude
*Hot water meters*

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

74 — Instruments de pesage électroniques
*Electronic weighing instruments*

75 — Compteurs d'énergie thermique
*Heat meters*

76 — Instruments de pesage à fonctionnement non automatique (*)
*Non-automatic weighing instruments (*)*

**DOCUMENTS INTERNATIONAUX**

*INTERNATIONAL DOCUMENTS*

D 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*

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(*) En cours d'impression
*Being printed*

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*

11 — Exigences générales pour les instruments de mesure électroniques
*General requirements for electronic measuring instruments*

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

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

14 — Qualification du personnel en métrologie légale
*Qualification of legal metrology personnel*

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

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

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

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

19 — Essai de modèle et approbation de modèle
*Pattern evaluation and pattern approval*

20 — Vérifications primitive et ultérieure des instruments et processus de mesure
*Initial and subsequent verification of measuring instruments and processes*

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

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