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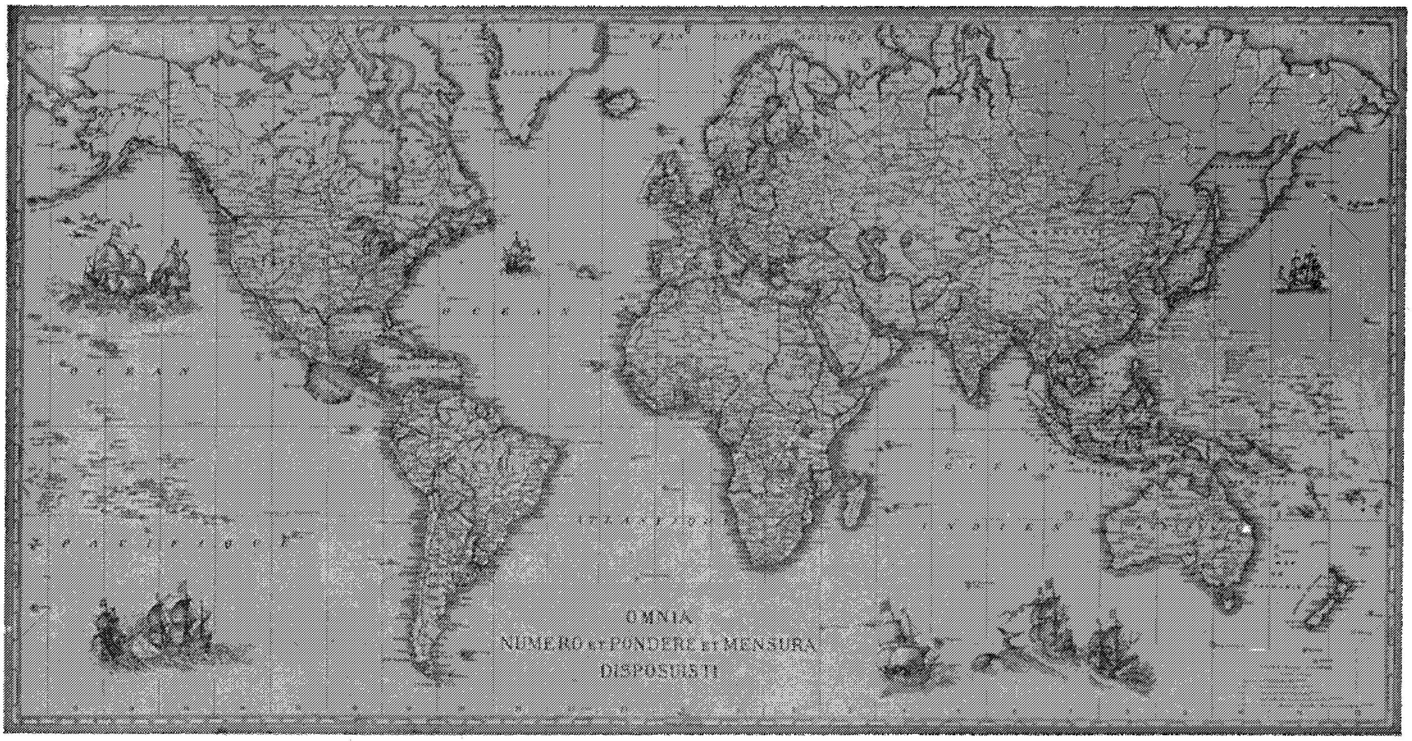

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DANEMARK

A 20 m MEASURING MACHINE for the CALIBRATION of STEEL TAPE MEASURES CONSTRUCTED by the DANISH NATIONAL BUREAU of WEIGHTS and MEASURES

by **Lars ROSENKILDE**
National Bureau of Weights and Measures

CONTENTS

1. INTRODUCTION

A typical assignment for a bureau of weights and measures is the calibration and verification of tape measures of considerable length. It can be extremely difficult to find equipment which is really suitable for solving this problem and it is, therefore, often necessary to construct the required facilities oneself. The Danish National Bureau of Weights and Measures has therefore decided to construct a 20 m measuring machine or bench for this purpose.

2. CONSTRUCTION

Outline

The basic principles are as follows :

A 20 m standard steel tape with dm-scale divisions is permanently placed on a temperature controlled base. With the assistance of a profile projector, which can move both along and across its length, this standard tape can be used for comparison. In order to provide reasonable possibilities for calibration, the apparatus is equipped with a 2.24 m incremental steel scale, which can be placed at any point along the whole apparatus (See figs. 1, 2 and 3).

Main Components

The profile projector (11), with magnifications 20 x and 50 x is fastened by a fixture (12) to a cross slide (19) which can be moved perpendicular to the 20 m standard tape by turning the handle (20). Focusing is carried out by turning the knob (13).

The light source (2) sends light through the light cable (3) to the profile projector's objective (16). The light is reflected by an angled mirror down into the object and reflected back again through the mirror, into the profile projector.

The profile projector, the light source etc. are placed on a carriage, which, by means of a 21.25 m long shaft, 30 mm in diameter (25), and two ball bushings (6), can be parallel guided a distance of 20.25 m. The front of the carriage is supported on a steel beam by two roll bearings (9) ; the temperature controlled base (7) is situated halfway between the shaft and the steel beam. It consists of two rectangular tubes 40 × 50 mm of 2.5 mm aluminium. The temperature control is carried out by circulating the water from a thermostat unit ; up through one tube, returning to the thermostat down the other tube.

A 2.24 m long incremental steel scale (8), with a resolution of 0.01 mm can be fastened along the whole length of the front side of the aluminium tube, parallel to the 20 m standard tape. An optical scanning head is placed on the under side of the carriage and adjusted so that it lies parallel to the incremental steel scale. The results of scanning can be read off from a digital counter (5), which can, in any position, be set at zero.

The carriage can be fixed by the lever (21), and fine adjustments can then be made by a micrometer (22), which is equipped with a digital display with a zero setting device.

The ends of the apparatus are fitted with rollers (15) for the tape measures, and at one end there is a motor driven bobbin winder (27), with variable rotation speed. The control unit (10) for winding is placed at the end where the weights for tensing the tape measures and the hangers for the tape winders (14) are found. The actual bobbin winder is at the opposite end at the standard tape's zero point.

Alignment

The measuring machine is set up on 21 T-iron bars (17), which supported the former equipment. These are supported by brackets (18) in order to stabilise the apparatus. In order to keep the apparatus level, the Al-profile table and the steel beam are level regulated by suitable distance pieces, at each point of support.

On the basis that the maximal, longitudinal inclination of the carriage may give at most, an error of the same order of size as the incremental photoelectric length measuring system's resolution i.e. 0.01 mm, the degree of accuracy of alignment is laid down as 0.1 mm/m.

This is achieved by lining up the shaft (diameter 30 mm) (25) with laser equipment and an extremely sensitive precision spirit level. Then the table (temperature controlled base) and steel beam are set up and the carriage mounted. The table and the steel beam are then aligned, in relation to the steel shaft (25), by fixing a dial indicator to the carriage and placing a precision spirit level on it.

This ensures that the movement of the carriage is parallel to the 20 m steel standard tape, the table and the incremental steel scale.

Alignment of the scanning head with regard to the incremental steel scale is carried out with a distance piece of suitable thickness.

Special Problems

Ordinary radiator thermostats are used in an effort to maintain the air temperature of the room, at the same level as that of the bench. If temporary differences do occur, the temperature of the water from the thermostat unit may alter slightly while running the length of the bench. In order to reduce this, a heat transfer compound has been laid between the two rectangular tubes.

As it was not possible to obtain rectangular tubing of sufficient length, it was necessary to join several pieces together with adhesive and with sleeves inside the joints. After mounting it was, however, shown to be necessary to seal these joints further, and this was done by evacuating the tubes and spreading a low viscosity epoxy resin around the outside of the joints. This epoxy was thus sucked into the cracks in the joints, which, after the operation was repeated three times, were eventually sealed.

To ensure that there are no air pockets in the rectangular tubes, air valves are mounted on the under side of them. The valves are inside the rectangular tubes connected to a pipe, which goes up to the under side of the table's surface, and when the valve is opened a narrow slit, facing the direction of flow, will catch any air that may be present, this air is then forced out.

3. FUNCTION

Positioning of the Object

The tape measure, or object, is placed directly on the temperature controlled surface. Calibrating tapes, the winder is hung on the hanger (14), the tape is rolled out about 20 m and the beginning of the tape is fastened at the opposite end. At the end with the hangers the tape is hung over a roller with very low friction in the bearing. Under the roller a weight is attached to the tape, which is therefore loaded with the entire weight, this induces a well defined tension in the tape. The mass of the weight is co-ordinated so that a predetermined tension is induced in the tape. Three tapes may be placed side by side on the table (7), as well as the standard tape.

Tapes which are shorter than 20 m can be extended by fastening a chain to the end ring.

When measurements are repeated, the tape (or tapes) are shifted slightly in the longitudinal direction between the measurements, so as to, as far as possible eliminate any systematic errors due to friction between the tape and the bench. The standard tape is tensed by a weight which hangs under a separate roller so that the movement of the other tapes will not effect the standard tape.

Winding

For tapes which are over 20 m in length, there is a motor driven winder for rolling up the tapes. This can give a conveying velocity from 0 m/s up to 0.5-1.4 m/s of the tape. In this way even very long tapes can easily be calibrated in 20 m sections. The winder has 4 slots and can therefore roll up to 4 tapes simultaneously.

Optical Contact with the Object.

Connection with the object is achieved through the profile projector, which has variable magnification, so that the required accuracy can be achieved. In order to minimise any local heating of the object « cold light » is used, i.e. light from which only very small amounts of energy can be absorbed.

Reading, Comparison

Measuring/calibrating is carried out as a comparison with the 20 m standard tape and/or the incremental steel scale. Any deviation from one of the dm-scale divisions on the standard tape can be measure as the profile projector is moved across the Al-profile table by the handle (20), and the size of deviation is registered by the incremental photoelectric measuring system of the micrometer (22). A given length is then determined from the deviations from 2 of the standard tape's divisions and the corrections on these divisions. Consecutive calibrations can also be taken by using the incremental steel scale (8). This will involve moving the incremental steel scale one, or more times for objects longer than 2.20 m. While it is being moved the readings already taken are kept in a store in the counter (5). This counter has BCD output and it will soon be equipped with a printer so that the readings are automatically registered. In order to ease everyday running, it has been suggested that two 0.27 m incremental steel scales are added to the apparatus at 10 m and 20 m respectively, so that while measuring the total length of 20 m, 50 m, or longer tapes it would not be necessary to move the incremental steel scale (8).

4. CALIBRATION OF THE MEASURING MACHINE

Temperature Control

As the room in which the measuring machine is constructed is only equipped with thermostatically controlled radiator valves, it may be necessary to run with the circulating water at a temperature below 20 °C during warm summer periods.

When the room temperature is above 20 °C, measurements of the room temperature and the related surface temperature of the table are collected, plotted graphically, and approximated to a straight line. This is done for a fixed water bath temperature.

From the graphic plot the combination of room and water bath temperatures can be obtained, which provide the required surface temperature of 20 °C. From a series of these graphs, the general connection between room and water bath temperatures can be deduced, which gives the bench the surface temperature of 20 °C. This connection approximates to a straight line in the temperature interval between 20 °C and 30 °C, which must under all circumstances go through the point (20 °C, 20 °C).

The temperature measurements referred to are taken with a Pt 100 resistance (flat coil) connected to a digital instrument with scale divisions of 0.1 °C.

This instrument can also be used to control whether the object has the required temperature prior to measurements being taken.

The results so far obtained show that a rise in room temperature from 20 °C to 25 °C necessitates a reduction in water bath temperature of approximately 1.2 °C to about 18.8 °C, with the present rate of flow.

If temperatures other than 20 °C are required this can also be carried out. With large differences between the room and object temperatures it is important to check the object temperatures frequently.

Total Length

After having obtained the correct surface temperature of 20 °C, the 20 m standard tape is then calibrated using a 1 m standard, which is traceable to the National Danish meter prototype and thus to BIPM.

The 20 m standard tape is calibrated as 20 x the one metre standard, with a magnification of 20 x on the profile projector. During the measurement the profile projector is not moved across the tape as there might be a risk of disturbing the carriage's fixed position.

Each time the 20 m standard tape is measured, care is taken to ensure that it is under a constant tension, thus it is first stretched with a force greater than 100 N, the weights are then removed and it is then finally retensioned with 100 N. This method of tensioning is used on the standard tape for everyday application.

The difference between 20 × 1 metre standard and the 20 m steel standard tape was measured by the incremental steel scale, which has previously been controlled with the 1 metre standard.

The mean result of 9 readings for the total length was :

20 m + 2.96 mm ± 0.12 mm

The uncertainty is in this case, the sum of a 99 % confidence interval for the measurement and 20 times the maximum possible error in the 1 m standard given on its certificate.

The Incremental Steel Scale and dm-scale divisions

The incremental steel scale (measuring system) was tested with the 1 m standard, and it was not possible to ascertain any greater deviation than the uncertainty caused by the resolution of 0.01 mm.

Three calibrations of the total length of the 20 m standard tape with 9 shifts of the incremental steel scale gave the following :

20 m + 3.017 mm, standard deviation : 0.015 mm

Calibration of the 1 m standard in 20 subsequent positions along the length of the table gave the incremental steel scale as having a mean correction of — 4 μm/m which corresponds very well with the manufacturer's specification. If the result obtained using the incremental steel scale is corrected according to this result, it still agrees very well with the result obtained using the 1 m standard.

The incremental steel scale was further used for 2 calibrations of the 20 m standard tape's dm-scale divisions. The mean value for these was found and the results were adjusted so that the total length matched the value obtained when the 1 m standard was used.

As this calibration of the dm-scale divisions does not require any movement of the profile projector across the carriage, whereas calibration with the 1 m standard results in 201 such cross movements, the former method was selected as the procedure to adopt. To check the results the dm-scale divisions were afterwards calibrated 3 times with the 1 m standard and the significant deviations found were rechecked. This result clearly showed that using the incremental steel scale is advantageous for this purpose.

Using this method the required traceability is achieved.

Future Calibration

Further calibrations will be carried out with the National Bureau of Weights and Measure's 2 m standard. Using this, the 2, 4, 6, 8, 10, 12, 14, 16, 18 and 20 metre marks can be individually measured and the subdivisions between them can be measured with the incremental steel scale, or the 2 m standard.

It is also possible to calibrate the 20 m standard tape with laser equipment, as a laser source can be placed at one end of the bench and the reflector on the carriage.

Such an apparatus could be set up permanently for daily use.

5. PRACTICAL APPLICATION

Verification

Verificating a 50 m tape measure with the zero point in the end ring, the measurements will be carried out as follows :

The tape winder is attached to one of the hangers (14) ; the tape measure's end ring is pulled along to the carriage, which slides over the tape measure, this is then drawn right to the end of the bench and fixed so that the zero point is roughly opposite the standard tape's zero point. At the other end a weight is attached to that part of the tape hanging over the roller. The carriage is moved with the handle (4), down to the standard tape's zero point, where it is then fastened with the lever (21) and the counter (5) is set at zero. The profile projector is then slid with the handle (20) over the tape, and using the micrometer (22) the profile projector is set over the tape's zero, and the deviation from the zero of the standard is read in the counter (5).

The carriage is then released and transported to the 10 m scale mark. The intermediate scale marks being controlled visually along the way, any deviation at the 10 m mark being registered by the micrometer (22). The weight is then removed and the end ring of the tape fastened to the bobbin winder (27). The tape is then transported by motor control 10 m forward and the weight again attached. Now the deviation of the 10 m mark from the standard tape's zero point is found with the incremental photoelectric measuring system, and the 30 m scale mark's deviation from the standard tape's 20 m mark is found with the micrometer. The operation is repeated and the last 20 m calibrated. The other scale marks being checked visually as before. The bobbin winder is set to unroll and the tape is wound up manually on its tape winder, as it rolls off the bobbin winder.

The 0.27 m incremental steel scales at the 10 m and 20 m points mentioned in chapter 3, will render superfluous readings with the micrometer and together with the printer referred to give a more reliable reading.

If, for example, all the dm-scale marks or several of a tape's scale marks are to be calibrated, consecutive calibrations can be carried out by sliding the incremental 2.24 m steel scale as described in chapter 3.

Long, thin objects could also have the distance between end surfaces, holes or other identifiable points, lines or surfaces measured, in so far as they could be placed on the bench.

It is estimated that the uncertainty of a normal 50 m calibration will be ± 0.6 mm taken as the sum of the maximum possible error of the 20 m standard tape added to the square root of the square sum of the uncertainties in positioning the centre line of the profile projector on the scale marks. In general the uncertainty will vary with the different methods used and the number of measurements, but is expected to be generally reduced with the introduction of the future methods of calibration outlined in chapter 4.

6. PHOTOGRAPHS WITH A LIST OF THE MAIN COMPONENTS

Figs. 1, 2, and 3.

1. Fixture for the net cable 220 V.
2. Light source.
3. Light cable.
4. Handle for moving the carriage.
5. Counter for the incremental photoelectric measuring system.
6. Ball bushing for 20 m guidance.
7. Table for positioning of the object.
8. Incremental steel scale.
9. Roller bearings for supporting the carriage.
10. Control unit for winding up tapes.
11. Profile Projector.
12. Fixture for the profile projector.
13. Focusing.
14. Hangers for hanging the tape winders on.
15. Rollers for the tapes.
16. Interchangeable objective.
17. T-iron bar fastened to the wall.
18. Brackets for the T-iron bar.
19. Cross slide for cross movements of the profile projector.
20. Handle for cross slide.
21. Lever for fixing the carriage.
22. Micrometer for fine adjustments of the carriage longitudinally.
23. Al-profile table.
24. Al-profile for strengthening the carriage.
25. Shaft 30 mm diam. for 20 m guide.
26. Pipe for water to the temperature control.
27. Bobbin winder with a motor for winding the tapes.

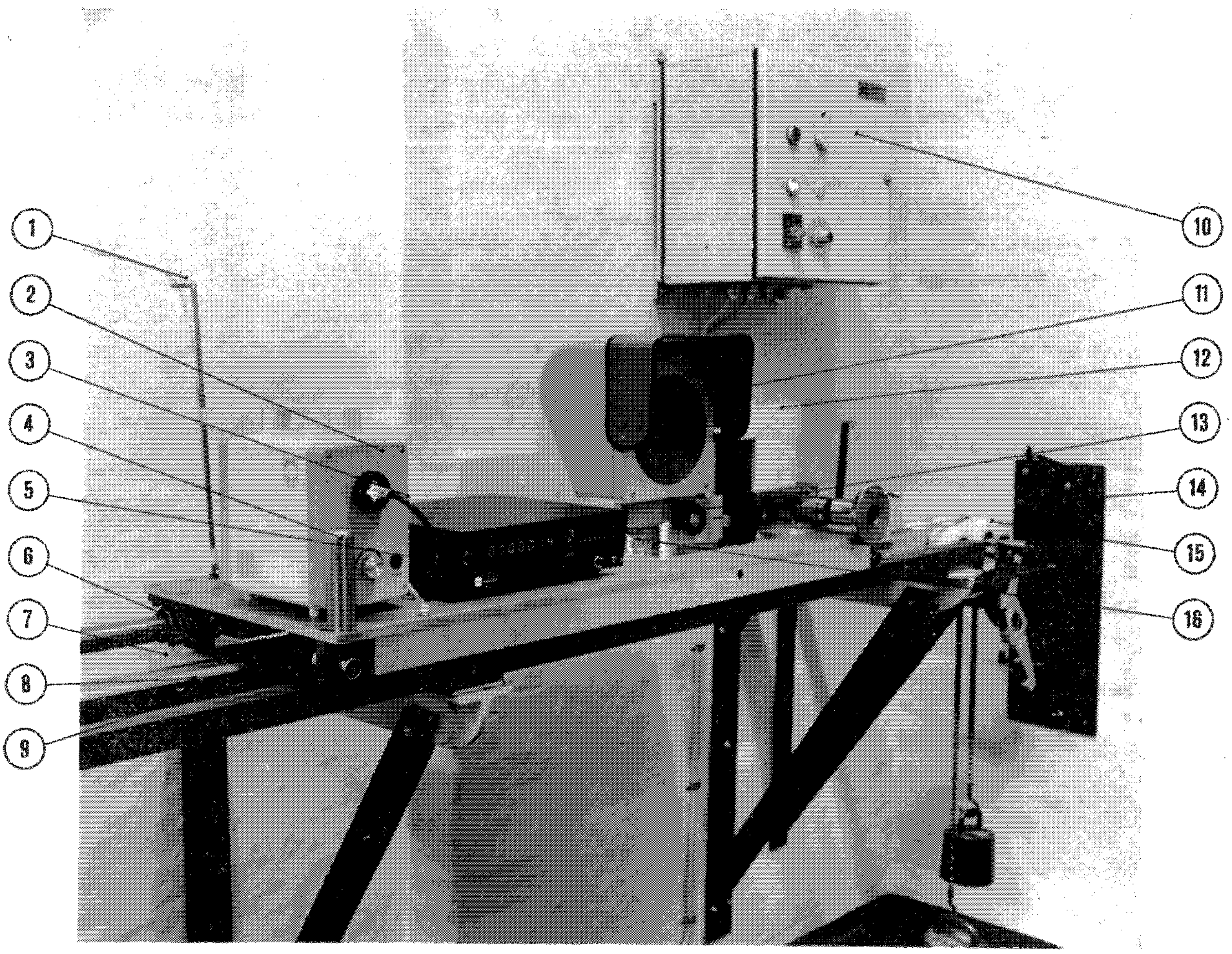


Fig. 1

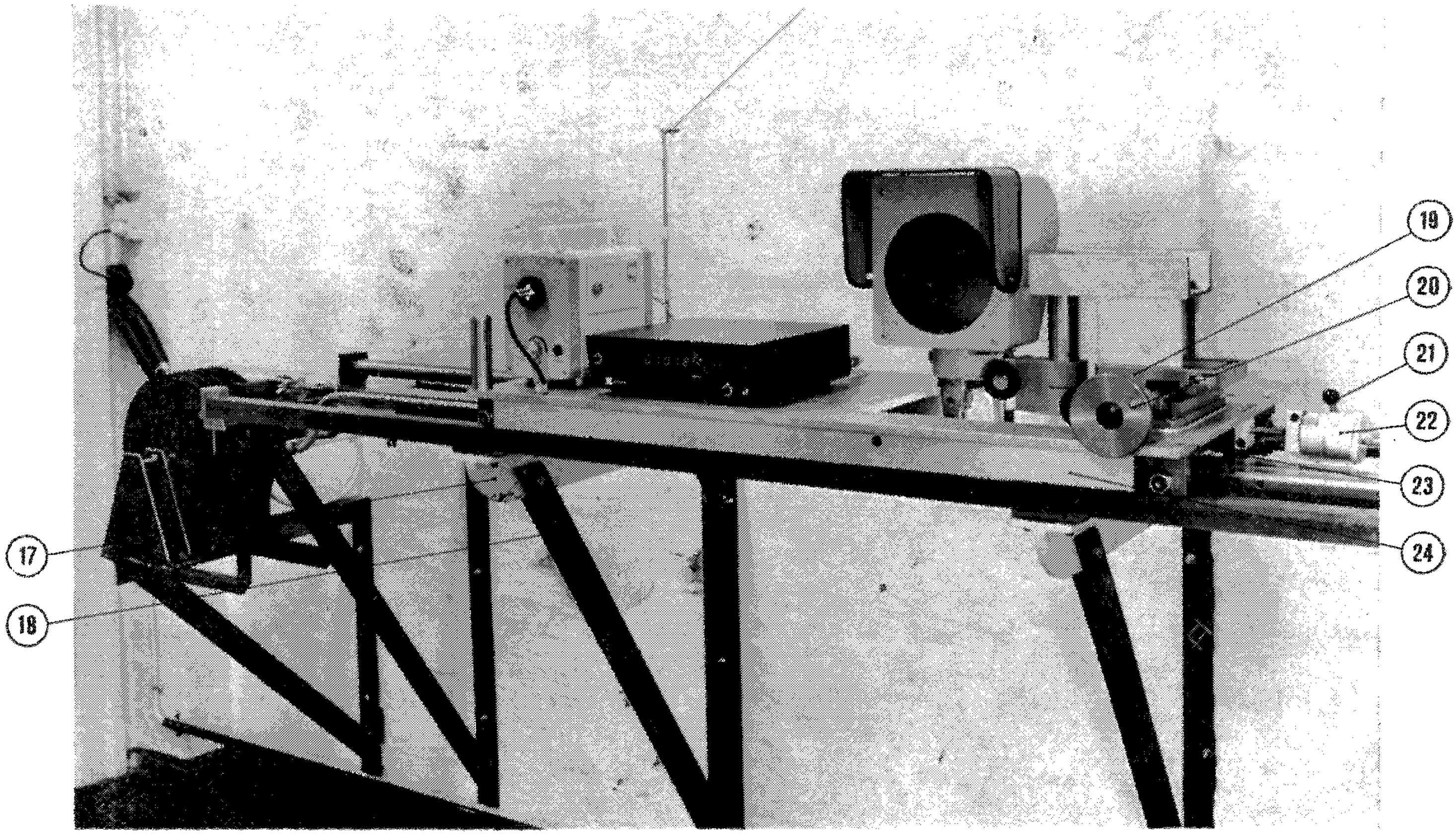


Fig. 2

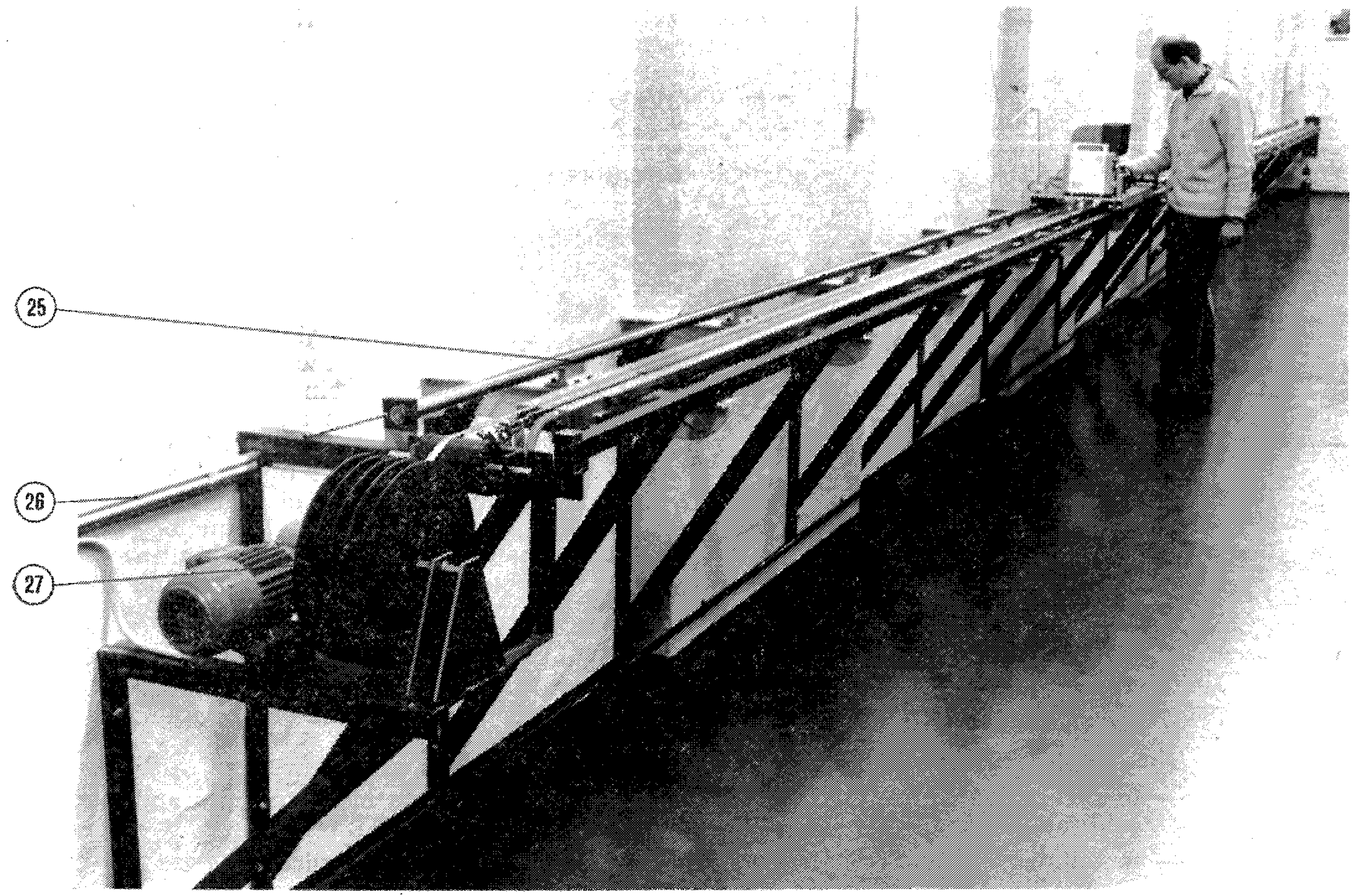


Fig. 3

FINLANDE

DEVELOPMENT of METROLOGICAL SERVICE in FINLAND

by **P. KIVALO**
Chief Director
Technical Inspectorate

The necessity of official organization and coordination of metrological activities in Finland has been established in numerous surveys and studies in the last decade. In 1976 the Technical Inspectorate supervised a project under appointment of the Ministry of Trade and Industry to map the metrological resources and demands in the country. In the steering group of the project the Technical Inspectorate, Ministry of Trade and Industry, Central Union of Industry, Electrical Inspectorate, National Board of Surveying, Finnish Geodetic Institute, Institute of Radiation Protection, Technical Research Center of Finland, Helsinki University of Technology and Finnish Standardization Association were represented. The project worked out a Report on Metrology which included a proposal for legislative action and a scheme for the organization of measurement services in Finland.

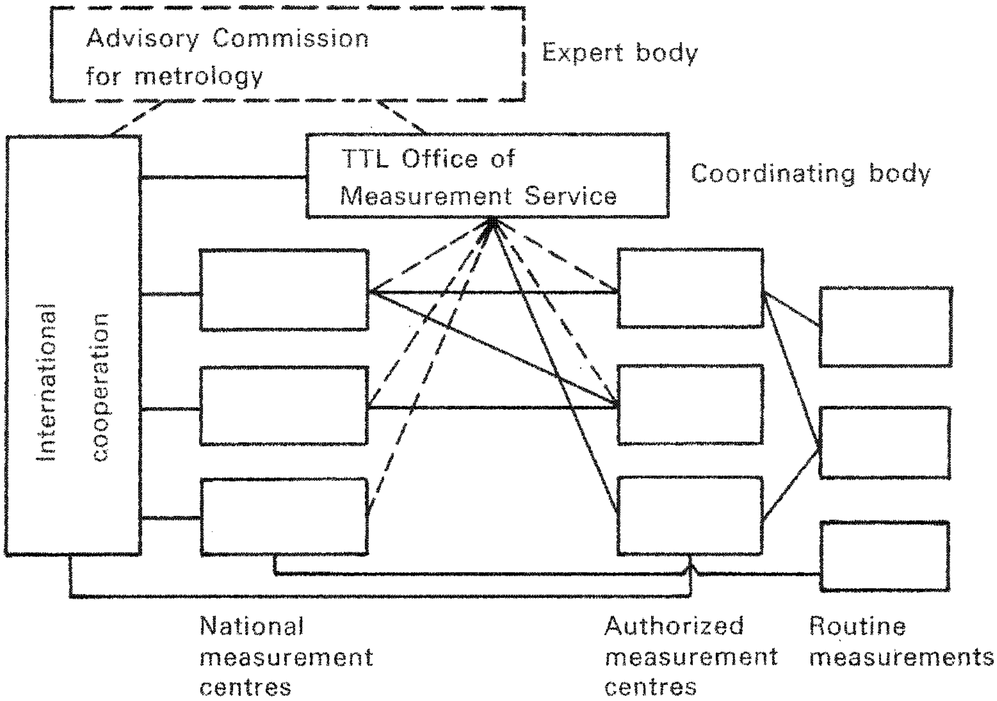
The Decree on Measurement Service in Finland (NO 489/78) was enacted on June 16, 1978 and came into force on July 1st, 1978. Thereby the Technical Inspectorate was appointed the coordinating and unifying authority of the organization.

The aim of the organization will be

- — to secure the supply of reliable and sufficiently accurate measurements and calibrations to those needing them,
- — to build up an internationally acknowledgeable calibration service,
- — to develop the metrological ressources in the country in such a way as to correspond to the needs of industry and trade,
- — to unify the terminology in the field and to promote its correct use and
- — to spread information on the significance of metrology in the society.

The service is based on voluntary coordination and optimal economic use of the existing metrological resources in the country. It consists of National Measurement Centres and Authorized Measurement Centres, Office of Measurement Service in the Technical Inspectorate (TTL) and of an advisory body, the Advisory Commission for Metrology. The model for the organization is basicly similar to that in Sweden, where the corresponding service has been working officially since 1975.

The scheme of the organization is seen in the picture.



The planned structure of the Finnish metrological organization.

In the Technical Inspectorate the organizing of a Metrological Department, including the Office of Weights and Measures and the Office of Measurement Service is being planned.

A National Measurement Centre is a state laboratory and will be appointed by the Government to act as a national primary laboratory for one or more quantities. It will be officially responsible for the traceability of the national standards to the internationally accepted units, and for the calibration of the equipment of the authorized measurement centres in order to assure the correctness of measurements in its field in Finland.

The appointment of the following institutes to National Measurement Centres was proposed in the Report on Metrology : the Electrical Engineering Laboratory and the Metals Laboratory of the Technical Research Centre of Finland, the Office of Weights and Measures of the Technical Inspectorate, the Finnish Geodetic Institute, the Department of Surveying of the Helsinki University of Technology and the Institute of Radiation Protection. The Technical Inspectorate concludes a cooperation contract with the National Measurement Centres.

The authorization for measurements and calibration in a specific field may be granted on application to public as well as private laboratories, which have sufficient knowledge, equipment and capacity for the measurements. The authorization is given by the Technical Inspectorate after obtaining reliable evidence on that the applicant meets the requirements. It includes a cooperation contract with them, and also supervises the activities of any measurement centre which is not a state office or public institution.

For the consideration of questions regarding metrology there is an Advisory Commission for Metrology, which among others is an advisory body to discuss any fundamental questions of metrology and research and planning closely related to it, and to promote the national and international cooperation in the field.

The Council of State has nominated the Chairman, Chief Director, Dr. Pekka KIVALO and 13 members representing the Ministry of Trade and Industry, the Technical Inspectorate, and other institutions participating in the project on Metrology, plus the National Board of Labour Protection and the Institute of Occupational Health, from January 1st, 1979 for a period of three years. The secretary of the Commission is Chief Inspector U. LÄHTEENMÄKI from the Technical Inspectorate.

Besides being the expert body in the field of metrology and supervising the metrological activities in the country the Commission forms a national committee within which the activities of the various international organizations dealing with the metrology are discussed and coordinated.

GRANDE-BRETAGNE

An INTER-LABORATORY COMPARISON of VOLUMETRIC STANDARDS in HOLLAND, FRANCE and the UNITED KINGDOM

by
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and
R.S. BAILEY
(Department of Prices and Consumer Protection, London)

SUMMARY

The authors conducted an inter-laboratory comparison exercise involving two 5-gallon volumetric standards. Over the period 20-24 June 1977, the laboratories of the Netherlands and French weights and measures services were visited and the measures calibrated. Three UK laboratories also took part.

Good agreement was obtained between the laboratories to within ± 0.015 per cent on the stated values for the copper and also for the glass volumetric measure. It was evident however that, in general, only the DPCP laboratory was ideally equipped for the regular gravimetric testing of Imperial volumetric standards up to 20 gallons. If uniform procedures and formulae were introduced it is suggested that even better agreement could be obtained at minimal expense.

1. INTRODUCTION

A Joint Working Party was formed in the United Kingdom with the object of finding an agreed basis for the determination of uncertainties, the method and stabilization of calibration of primary volumetric standards and proving tanks used in the measurement of liquid quantities.

By December 1976 definite ideas for the implementation of an inter-laboratory comparison exercise had emerged and reference measures had been made available. In March 1977 it was agreed that brief measuring instructions only should be provided. Apart from this it was agreed that a rigid measuring procedure should not be insisted on and that each laboratory should be asked to follow their normal measuring procedures.

The planned itinerary was to commence and end with weighings at the Department of Prices and Consumer Protection Laboratory in London of two 5-gallon measures in copper and glass. A DPCP 10 kg Tertiary Mass Standard was also taken for comparison with the Netherlands and French Standards, maintained in their respective capitals. The laboratories involved were :

Department of Prices and Consumer Protection (London),

Dienst van het Ijkwezen (The Hague),

Service des Instruments de Mesure (Paris),

Trading Standards Department, Warwick County Council (Warwick), and

National Engineering Laboratory (Glasgow).

After completion of the preliminary weighings at DPCP on 9 June 1977 the United Kingdom representatives, Mr P.L. LANGBORNE, NEL, and Mr R.S. BAILEY, DPCP, visited the Dutch and French laboratories in late June and the two UK laboratories in early July. Final determinations were made in London on 14 and 22 July and a repeat weighing (necessitated by a defective balance) in Glasgow on 14 October.

2. THE VESSELS USED

The 5-gallon copper vessel is shown in Fig. 1(a). The emptying and drainage time was taken as 1 1/2 minutes from opening to closing the delivery valve. The filling time of 1 minute 45 seconds ensured that the water level in the overflow dish was maintained above the level of the weir thus permitting the temperature of the water to be taken. Closing the filling valve allowed the dish to empty through the drain-away pipe leaving the free surface of water in the vessel at the level of the weir.

The coefficient of cubical expansion for the vessel was taken as 50.1×10^{-6} K^{-1}. The body was fitted with a thermometer pocket.

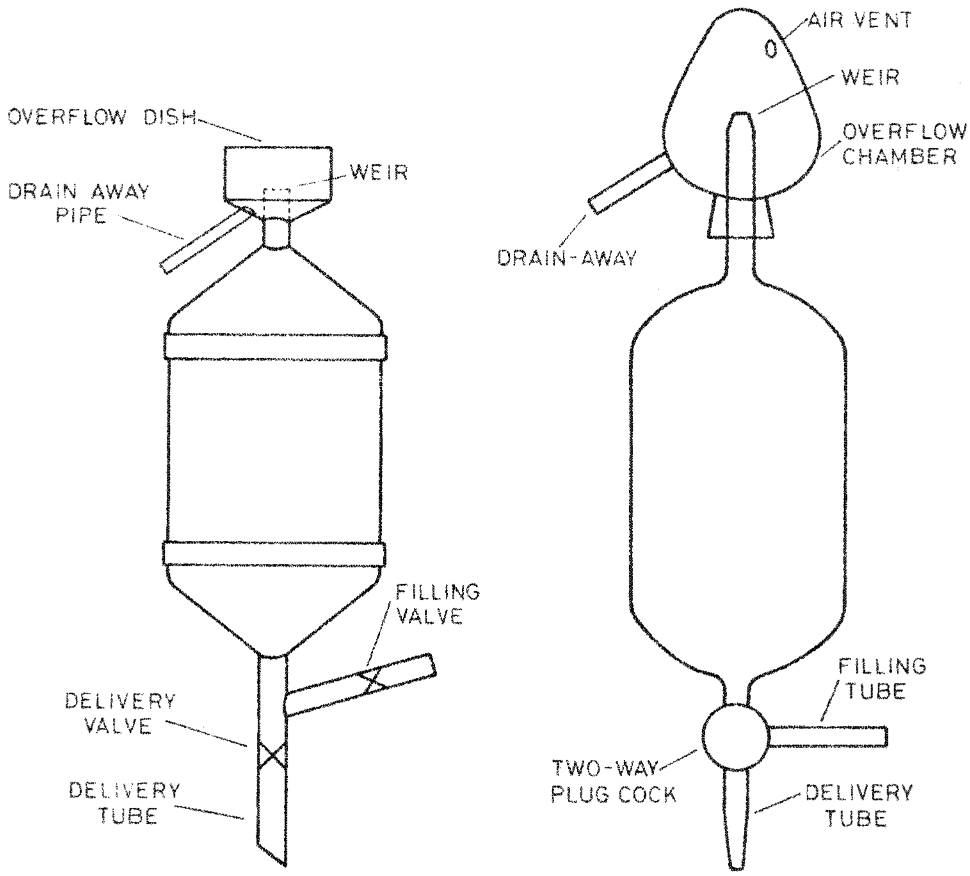
The 5-gallon glass vessel is shown in Fig. 1(b). An air vent in the top of the chamber allows the insertion of a thermometer. The vessel is housed in a wooden case having doors at the top and bottom giving access to the overflow chamber and the two-way cock.

The emptying and drainage time was taken as 2 minutes from opening to closing the two-way cock. The filling time of 2 minutes ensured that the water level in the overflow chamber was maintained above the level of the weir so permitting the temperature of the water to be taken. Closing the two-way cock allowed the chamber to empty through the drain-away pipe leaving the free surface of the water in the vessel at the level of the weir.

The coefficient of cubical expansion for the vessel was taken as 10.0×10^{-6} K^{-1}.

3. GENERAL OBSERVATIONS ON THE LABORATORIES VISITED

All the laboratories visited used the well-known « back weighing » technique to calibrate the measures (Fig. 2). Water containers with a capacity slightly in



(a) 5 GALLON COPPER MEASURE

(b) 5 GALLON GLASS MEASURE

Fig. 1 : Design of copper and glass measures.

excess of 5 gallons were provided. Brass mass standards of 50 lb, or near-metric equivalents, were placed in the container and counterpoised on a bullion balance against brass weights.

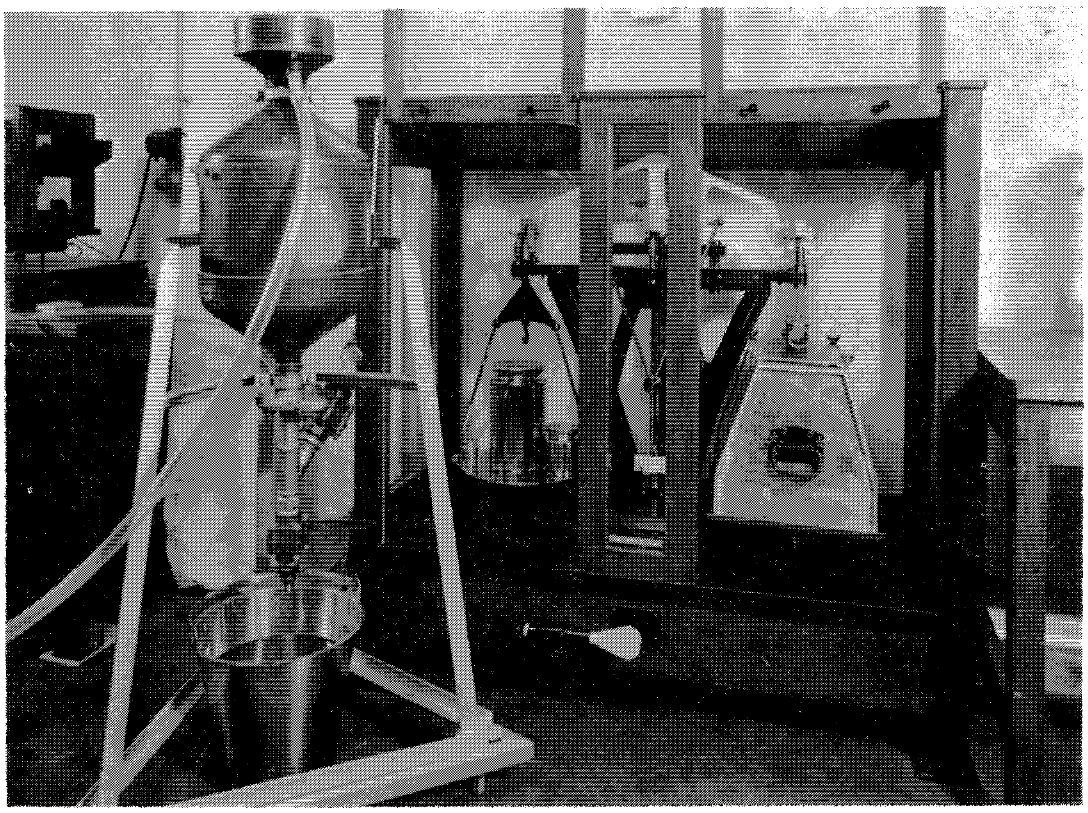


Fig. 2 : The copper measure being tested at N.E.L.

The mass standards were then removed and water delivered from the measure into the container. The container was then replaced on the balance and the beam rebalanced to zero indication by the application of weights to the appropriate side. Despite the apparent simplicity of this technique a number of minor variations in procedure and formulae used were revealed at the various locations. Fortunately none of these produced significant errors in the volumetric determinations.

4. EVALUATION OF THE RESULTS

The main procedures involved in the calibrations are as follows.

a The measure is filled with water to the level of its overflow weir and the equilibrium temperature of water and measure noted.

b It is essential to determine the unique volume of water existing under these conditions because no other volume of water, though of the same mass, will fulfil the dimensional requirement of exactly filling the measure to overflow.

c Since the volume of water cannot be measured directly it is drained into a suitable container and weighed, making the necessary buoyancy corrections. It is then possible to determine the initial volume by dividing the corrected weight by the water density at the initial temperature.

d If the coefficient of cubic expansion of the material of the measure is known the volume can be corrected to a stated reference temperature.

Unfortunately inaccuracies can creep in as soon as the water is removed from the measure. These are drainage, temperature variations, water density and air density. Each is examined separately in the following notes.

4.1. Drainage Inaccuracies

In each of the laboratories visited, 1 1/2 minutes drainage time was allowed for the copper and 2 minutes for the glass measures. This raised the question of whether sufficient drainage time was allowed to obtain consistent results.

Later, following further discussions of this question a series of drainage tests were conducted on the two measures at NEL. In regard to the 5-gallon copper measure it was observed that a noticeable quantity of water drained from the measure after the cessation of the main flow. The actual point at which the main flow ceased was difficult to define with any degree of precision. However, it was evident that, after an elapsed time of 60 seconds (timed from the opening of the outlet valve) a more stable flow situation was obtained and it was possible to make a number of collection runs of varying duration. The procedure followed was to fill the measure to weir level in the normal way, open the outlet valve and, timing from 60 seconds after valve opening, collect the total amount of water draining from the measure in successive time intervals, for example at 60 + 15, 60 + 30, ..., 60 + 600 seconds.

The total amount of water leaving the measure in this way is shown in Fig. 3. By drawing a smooth curve through the plotted points of Fig. 3 and taking the slope it was possible to depict the change of flowrate of the water leaving the vessel after the cessation of main flow, see Fig. 4. This indicates that the flowrate falls rapidly up to a time of about 360 seconds, steadily but less rapidly to 660 seconds and eventually to zero at some time in excess of 660 seconds. It was felt that a drainage time in excess of, or even of the order of, 660 seconds would be unrealistic and so an attempt was made to derive from the data, some shorter time period which would be acceptable as a drainage time.

To this end the data were plotted as log flowrate against time in Fig. 5. It can clearly be seen that a logarithmic relationship between flowrate and time exists after 240 seconds (4 minutes) from valve operation. This period is therefore proposed as a more suitable drainage time. Note also that at 240 seconds the flowrate has fallen from 0.043 to 0.016 ml s^{-1}.

Similar tests to the above on the 5-gallon glass measure showed that the surface characteristics of the interior of the measure were such that drainage ceased entirely within a few seconds of the cessation of the main flow. Tests made at short intervals, eg 15, 30 and 45 seconds after the cessation of main flow, were inconclusive, due possibly to the difficulty of defining the point at which the main

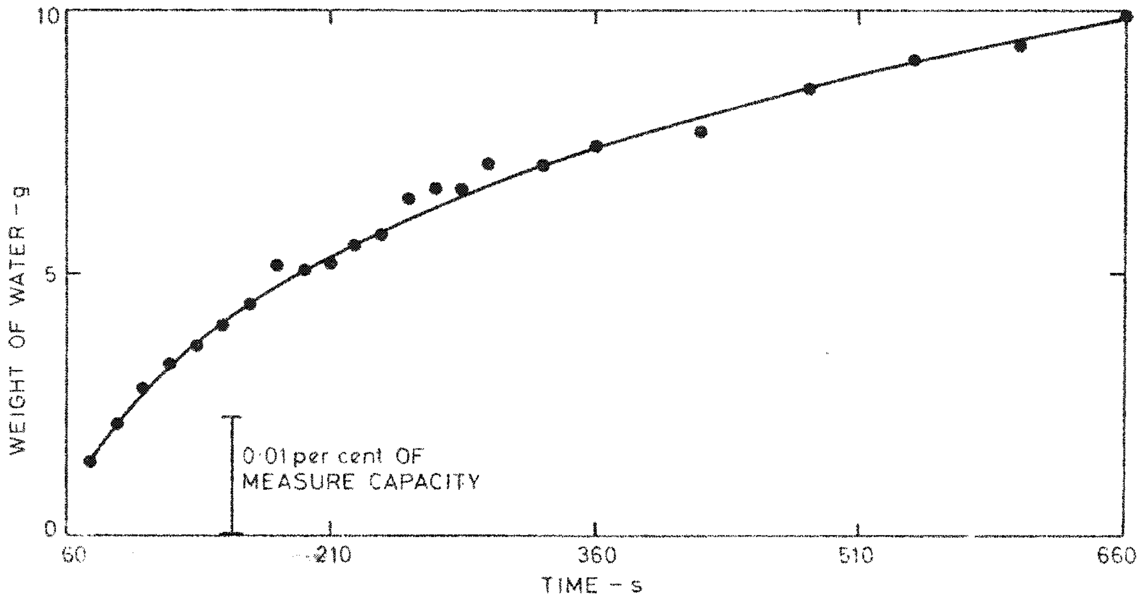


Fig. 3 : Weight of drainage water against time (from valve opening) - 5-gallon copper measure

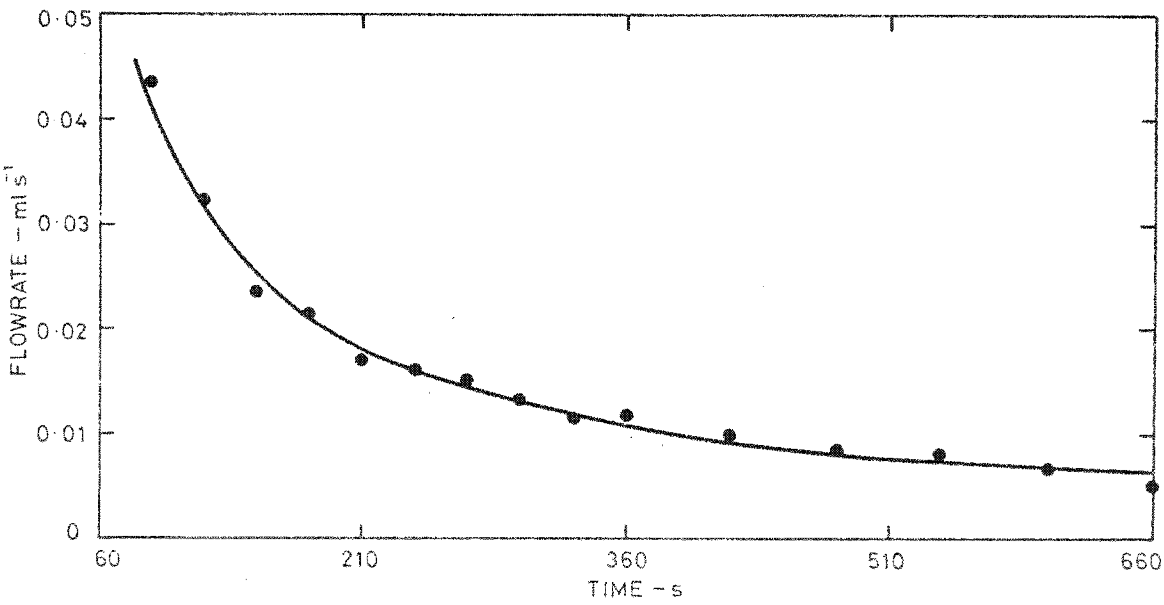


Fig. 4 : Flowrate against time.

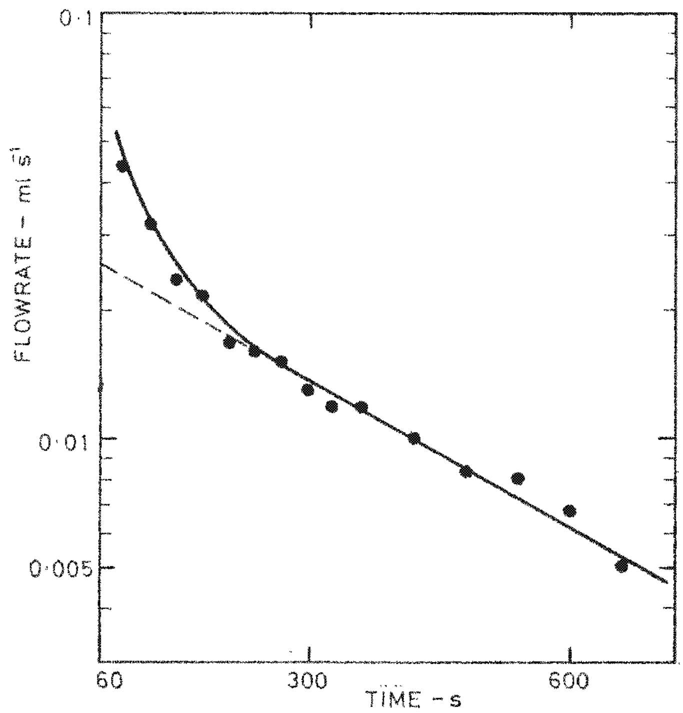


Fig. 5 : Log flowrate against time.

flow actually ceased. It would seem that a mechanism similar to that described above operates but over a narrow timescale.

Extension hoses attached to the outlet were found to affect the time at which the main flow apparently ceased but with all hoses removed, main flow appeared to cease between 80 and 81 seconds after valve opening and all drainage by 120 seconds. Thus a drainage time of say, 90-120 seconds would be quite suitable for this measure.

It was concluded that, when doubt exists on an appropriate drainage time for a measure, a simple timing and collection test is useful as a mean of arriving at a sensible time.

4.2. Temperature Variations and Water Density Inaccuracies

It is unlikely that the water temperature and density during the weighing process will correspond with the initial temperature and density in the measure. Again it could be asked whether any disparity would be large enough to significantly affect the calculation of the final volume.

Density inaccuracies can also result from the use of incorrect tables. The French and NEL use distilled water for which internationally agreed density tables exist (1). The Dutch use de-ionized water, which also corresponds to these tables. DPCP and Warwick use public supply water. The density of the water used at DPCP has been checked at the NPL.

No concensus of opinion exists on the magnitude or relative importance of errors likely to arise due to a disparity between the water temperature and density observed during weighing and that observed on the initial filling of the measure. Indeed two of the four formulae used in capacity determination in the various laboratories use only the temperature and density determined during weighing and a third makes only a limited use of the initial temperature measured on filling.

In practice the measure is filled with a volume V_m of water and the temperature of the water, t_m, may be measured. Initially V_m is unknown, It can be found by determining the mass, which is equal to the buoyancy-corrected weight, W_{COR}, of the water and dividing by the density, ρ_m, of the water at t_m. Thus

$$V_m = W_{COR}/\rho_m.$$

When V_m has been found it can be adjusted to give V_r, the volume at a chosen reference temperature, t_r, by multiplying by

$$[1 + \Phi\ (t_r - t_m)]$$

where Φ is the coefficient of cubic expansion of the measure material.

$$V_r = V_m\ [1 + \Phi\ (t_r - t_m)].$$

To obtain W_{COR} the water is discharged into a suitable container and weighed to give an apparent weight, W_a. The temperature can again be measured at this stage and found to be t_w — not necessarily the same value as t_m. The usual buoyancy correction is applied to give

$$W_{COR} = W_a\ W_a\rho_a \left(\frac{1}{\rho_w} - \frac{1}{\rho_s}\right)$$

where ρ_a is the density of air,

ρ_w is the density of water at t_w, and

ρ_s is the density of the weight used.

The complete formulae are

$$V_m = \frac{W_{COR}}{\rho_m} = \frac{W_a + W_a\rho_a \left(\dfrac{1}{\rho_w} - \dfrac{1}{\rho_s}\right)}{\rho_m}$$

$$V_r = [1 + \Phi\ (t_r - t_m)] \left[\frac{W_a + W_a\rho_a \left(\dfrac{1}{\rho_w} - \dfrac{1}{\rho_s}\right)}{\rho_m}\right].$$

The Netherlands formula (using the same symbols) is

$$V_m = \left[\frac{W_a \left(1 - \dfrac{\rho_a}{\rho_s}\right)}{1 - \dfrac{\rho_a}{\rho_w}} \; \frac{1}{\rho_w} \right]$$

$$V_r = [1 + \Phi\,(t_r - t_w)]\; V_m.$$

The French formula is

$$V_m = \frac{\left(\dfrac{W_a\rho_a}{\rho_w} - \dfrac{W_a\rho_a}{\rho_s}\right) + W_a}{\rho_w}$$

$$V_r = [1 + \Phi\,(t_r - t_w)]\; V_m.$$

The Netherlands and French formulae are practically equivalent and differ only from the complete formula in the use of t_w and ρ_w in the place of t_m and ρ_m throughout.

The DPCP formula is

$$V_{r(gal)} = \left[W_a \left[\left(\frac{0.001\,218 - \rho_a}{8.136}\right) + \left(\frac{0.998\,859 - \rho_w}{\rho_w}\right) + \left(\frac{\rho_a}{\rho_w} - 0.001\,218\right) + \Phi\,(t_r - t_m) \right] + W_a \right] \Big/ K$$

where 0.001 218, 0.998 859 and 8.136 are the relative densities of air, water and weights used in the legal definition of the gallon. K is 10 when W_a is in pounds, 70 000 when W_a is in grains.

The volume V_m can be expressed as either W_{COR}/ρ_m (as in the « complete » formula) or W_{COR}/ρ_w (as in the French and Dutch formulae). Similarly, adjustment of V_m to V_r can either involve the expressions $(t_r - t_m)$ or $(t_r - t_w)$ respectively. The first-mentioned statements are obviously « correct » in the strict meaning of the word. If by chance $t_m = t_w$ the expressions are equivalent. Generally however the possibility must be faced that $t_m \neq t_w$. In this event the use of the latter « incorrect » expressions might result in an appreciable error in the calculation of V_r.

An analysis of the Dutch, French and British formulae shows that a difference of 0.1 K between the filling and weighing temperatures, t_m and t_w, will produce an error of 21 p.p.m. (0.002 per cent) in the volume V_m.

This error may appear small but it can be occasioned by a temperature difference of 0.1 K, the closest to which the cheaper mercury-in-glass thermometers can generally be read. It represents one tenth of a division on the results graph, Fig. 6.

It is debatable whether errors of this magnitude can be considered to be serious. Nevertheless it is clearly important to measure t_m and t_w since large differences would cause errors which would warrant remedial action.

4.3. Air Density Inaccuracies

Air density inaccuracies can arise in applying a correction for the buoyancy of the atmosphere. Since the total correction is unlikely to exceed 0.1 per cent of the quantity being measured the inaccuracy is unlikely to be serious but the question arises of whether it is really necessary to determine all of the three parameters affecting air density - barometric pressure, temperature and vapour pressure.

Thus differences in procedure exist in the matter of determining the air density to be used in the buoyancy correction. Some laboratories prefer to measure relative humidity and vapour pressure in addition to temperature and barometric pressure and combine the whole in a formula to determine air density.

On the whole, British laboratories, including DPCP, measure only temperature and barometric pressure, determining air density from tables relating to a fixed value of relative humidity, for example, 50 per cent. (Correction tables are usually applied when humidity differs from this).

The whole question has been carefully examined in a paper by Dr A.T.J. HAYWARD (formerly of NEL) (2).

5. RESULTS

5.1. Volume Measure Results

Because of the diversity of formulae used the procedure followed in presenting the results has been that of correcting a declared volume to a volume at 15.56 °C (60 °F).

The results are shown graphically in Fig. 6. In the capacity determinations on the glass measure all but two of the 23 results fell within 0.015 per cent of the mean and there is little doubt this accuracy could be improved upon if a uniform procedure was introduced.

The statistical uncertainties have been calculated from the data. The mean values obtained by each laboratory have been calculated together with the unbiassed standard deviation of the actual set of results. The overall weighted mean of all the laboratories mean values for both the copper and glass measures was then determined (5.018 82 and 4.996 49 gallons respectively). This is slightly different, as is to be expected, from the simple averages of all the results (24 for the copper and 23 for the glass measure) which are indicated in Fig. 6.

Based on the weighted mean values an estimate can be made of the 95 per cent confidence limits within which it would be expected that the stated mean result from any one of the laboratories might be expected to lie. This was found to be almost the same for both measures, which is perhaps not unreasonable, at ± 0.023 per cent and ± 0.022 per cent respectively. It represents the « average » laboratory accuracy : clearly an examination of the results suggests that some laboratories

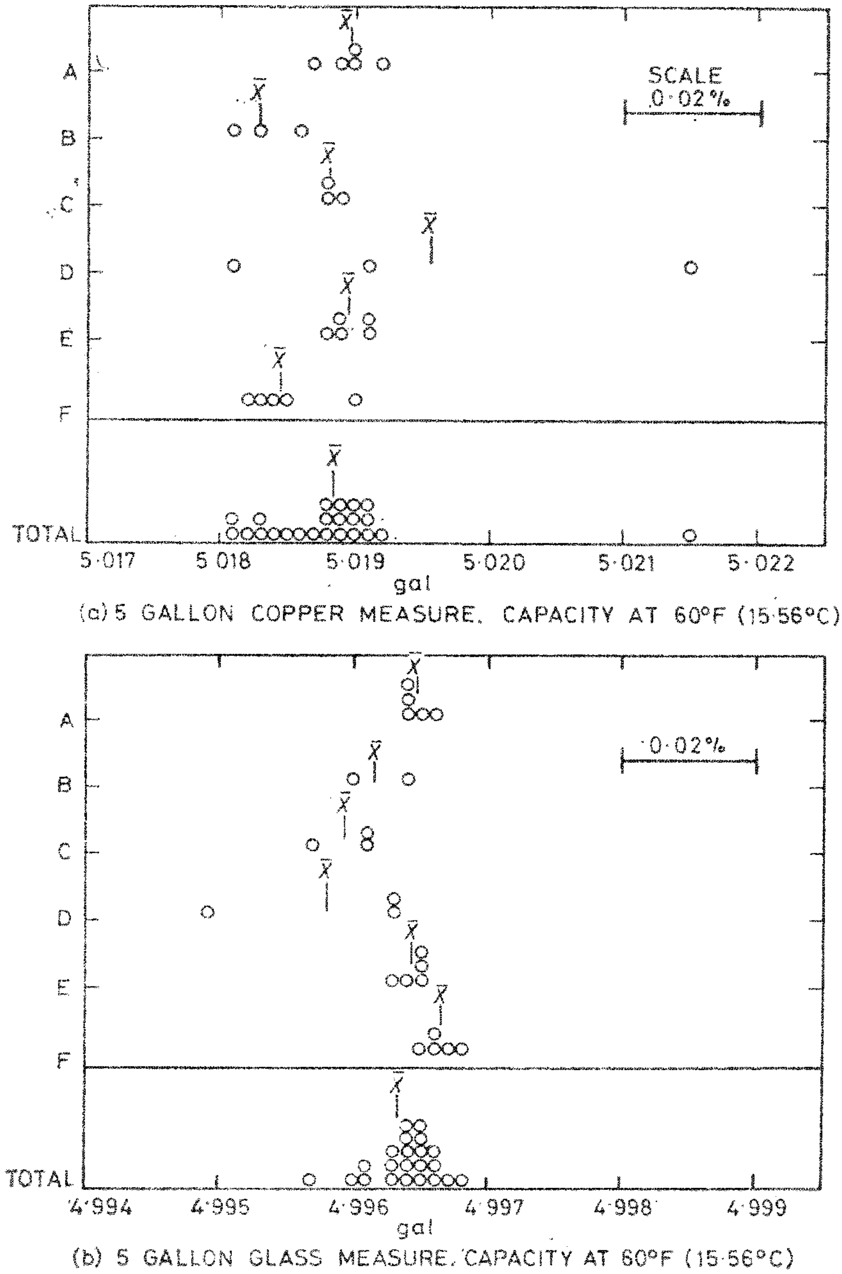


Fig. 6 : Results of capacity determinations.

can be expected to be better than this, but quite rigorous controls would be required.

In terms of the mean values from laboratories the actual variations were within ± 0.014 per cent for both the copper and glass measures. Rounding this to ± 0.015 per cent is justified for a general conclusion from these tests.

This may be compared with the estimates of uncertainties given by three of the laboratories. An uncertainty of ± 0.015 per cent for these measures would be ± 3.4. ml.

Laboratory	Stated uncertainties			
	Copper measure		Glass measure	
Dienst van het Ijkwezen	± 0.002 dm^3	2 ml	± 0.002 dm^3	2 ml
SIM	± 0.3 cm^3	0.3 ml	± 1.2 cm^3	1.2 ml
DPCP	± 0.000 87 gal 95 %	3.9 ml	± 0.000 32 gal 95 %	1.4 ml

In the absence of a clear definition of how these uncertainties were derived or defined, they have been omitted from the results given in Fig. 6.

5.2. Mass Comparison Results.

The results of the determination of mass of the 10 kg standard weight were as follows :

Paris — 10 000.034 g
The Hague — 10 000.038 g
London — 10 000.032 g.

The variation here is well within a range of 1 p.p.m. and is so close that variation in the mass of the standard weights used could have no detectable effect upon the volume determinations carried out in these three laboratories.

6. COMMENTS

None of the laboratories, except DPCP, was specifically equipped for the regular gravimetric calibration of volumetric standards in the 5 gallon (or 20-25 litre) range. It would be interesting to know why there appears to be little demand for such calibrations outside London. Are there fewer legal requirements for calibrations at this level, or is the answer simply that the need for measures at this level is met by large capacity glassware, calibrated up from smaller volumes on a step-by-step procedure ?

The exercise, though modest in scope, was a sucess in that :

a It provided the necessary reassurance that no serious disagreement on methods or results in the calibration of these volumetric standards exists between three major EEC partners.

b It has been shown that more standardization of procedures, including the calculations, would result in even closer agreement. This could be obtained at negligible extra cost.

c Potentially fruitful contacts have been made with a small number of key personnel in the weights and measures services of two EEC countries.

ACKNOWLEDGEMENT

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List of figures

INFORMATIONS

« SPRAVOCHNIK po MEZHDUNARODNOI SISTEME EDINITS »

par Monsieur le Pr Dr **G. D. BOURDOUN**
Ancien Vice-Président et Membre d'Honneur
du Comité International de Métrologie Légale

La bibliographie métrologique s'est enrichie de l'ouvrage de Monsieur le Docteur G.D. BOURDOUN intitulé « **Guide du Système International d'Unités** » (*).

Une partie essentielle du livre se rapporte à la présentation des décisions qui ont été prises par les organes de la Convention du Mètre au sujet du SI. L'Auteur évoque la structure du système, ses unités de base et unités supplémentaires, les règles de formation et de dénomination des unités dérivées et des multiples et sous-multiples décimaux d'unités.

Dans une autre partie importante du livre, les unités sont traitées d'une façon descriptive. On y trouve, domaine par domaine, une centaine d'unités les plus répandues avec leurs définitions et caractéristiques, des aspects pratiques d'utilisation et, s'il y a lieu, avec l'indication du mode suivant lequel un étalon primaire de l'unité peut être réalisé.

Un chapitre est consacré notamment aux échelles de températures, thermodynamique et pratique. Dans un autre, l'Auteur passe en revue les divers systèmes d'unités électriques et magnétiques et souligne les raisons qui ont déterminé le choix de la forme rationalisée de l'équation du champ électromagnétique pour le Système International d'Unités.

C'est bien l'esprit didactique du Professeur BOURDOUN, chargé de la chaire de métrologie d'une Grande Ecole, qui l'incite toujours à expliquer les raisons des décisions prises et à exposer leurs conséquences pratiques. De nombreux exemples aident à illustrer les diverses applications types.

Le guide contient quelques soixante-quinze tableaux, parmi lesquels se trouvent : la liste des unités en usage avec le SI, la liste des unités ayant reçu des noms spéciaux, les listes d'unités dérivées, les symboles des grandeurs recommandés par l'IUPAP, les multiples et sous-multiples préconisés par l'ISO, les valeurs des constantes physiques, enfin des tableaux de conversion des unités n'appartenant pas au SI en unités de ce système.

Nous sommes heureux de présenter cet ouvrage précieux de Monsieur BOURDOUN dans le numéro du Bulletin paraissant au moment du 25e anniversaire de la constitution de la Commission du Système d'Unités, par le Comité International des Poids et Mesures, en octobre 1954.

C'est cette Commission qui a inspiré les décisions de la Conférence Générale sur l'établissement du Système International d'Unités et c'est Monsieur le Docteur BOURDOUN qui en a assumé la présidence pendant dix années, avant qu'elle ne soit transformée en Comité Consultatif des Unités.

Z.R.

(*) Aux Editions des Normes, Moscou 1977 - En langue russe.

VIIIe CONGRÈS IMEKO

Moscou, mai 1979

Le 8e Congrès IMEKO s'est tenu à Moscou, en mai dernier. L'OIML y était représentée par le Dr V.I. ERMAKOV, Vice-Président du Comité International de Métrologie Légale (GOSSTANDART d'U.R.S.S.) et par le Dr F. PETIK (Office National des Mesures de HONGRIE, et responsable de plusieurs Secrétariats rapporteurs OIML).

A l'occasion de ce Congrès, s'est déroulée une « Table ronde » du Comité Technique IMEKO TC 8 « Métrologie » au cours de laquelle le Dr PETIK a prononcé une intervention que nous avons le plaisir de reproduire ci-après.

SOME CHARACTERISTIC RECENT CHANGES in the VERIFICATION of MEASURING INSTRUMENTS *

by **F. PETIK**
National Office of Measures

Verification of measuring instruments is the most important supervising intervention of public authorities in ensuring correctness of measurements at various transactions.

In our days we are witnessing an apparent change in instrument verification what is a consequence of technological development, especially of that of instrument technology.

Let us take a simple example. Balances used for weighing foodstuffs in stores are devices similar to those used some fifty years ago, at least the functioning is basically the same, consequently verification procedures did not change much.

The up-to-date counterpart of the balance as verified instrument is a measuring station at an oil pipe-line at the frontier of two countries, where very large quantities of fuel are measured and accounted for. This transaction should of

(*) Paper read at the Round Table Meeting of IMEKO TC 8 « Metrology » during the VIII IMEKO Congress in Moscow, May 23, 1979.

course be done by using verified instruments, better to say, by a large complex of instruments verified in their entity.

The differences between the two examples are evident. We shall try to systematize the most important of them.

SERIES PRODUCTION - MODULAR COMPOSITION

Classical verified instruments were produced, in general, in larger series, the pattern approval was published in the official gazette of the verification authority.

In our days, measuring equipments of modular design may differ from each other in each case, in accordance with given requirements. Pattern examination is often performed on the individual modules. Permission of verification is sometimes issued for the complete measuring equipment on the basis of those for the component sub-units.

WORKING PRINCIPLE

Formerly most instruments were working on a mechanical principle, the design permitted a visual detection of faults even by not specially skilled people. Today the working principle is in many cases electric, the intricacy of the design has grown enormously.

EXPECTED LIFE

In the case of mechanical instruments, verification techniques employed were suited to ensure correct measurements within the duration of validity of stamping. Electronic measuring equipments are built up of hundreds of components, the expected life of which is of a stochastic character. The useful life of the complete measuring equipment, or the life expectance to the first failure cannot be determined by a pattern examination performed on one or two instruments. Prescriptions regarding defects during the validity of stamping require new formulations. « Fool-proof » electronic equipments working without intervention for several years are only exceptions. On electronic devices faulty functioning cannot be detected by not specialists. Therefore it is of primary importance that in case of errors or faults the instruments should signal this condition or should not indicate at all.

STAMPING

On classical verified instruments the vital instrument components permitting an adjustment of indication are protected by the stamp, impeding unauthorized intervention by the user.

On the contrary, vital parts of electronic equipment require frequent readjustment (zeroing, balancing, etc.), consequently the application of stamps is sometimes difficult.

REQUIRED SKILL FOR INSTRUMENT OPERATION

In contrast to the relatively simple operation of the old instruments, what could be learned by practically everybody in a short time, the operation of complicated modern instruments often requires a high degree of specialized knowledge.

INCREASED DIVERSITY

The number and diversity of instruments and measurements has increased to such an extent that verification authorities are not always capable to verify all the instruments serving as a basis of commercial transactions. Sometimes the formerly employed efforts of the prevention of fraudulous use are substitued by repression measures.

Type approvals are often given to individual composed measuring assemblies. For a household gas consumption (flow) meter a type approval can be issued on the basis of examinations performed on one (or several) instruments taken from series production. The measuring apparatus at flow metering stations is frequently of individual design, or at least the measuring system composed of individually approved instruments is individual.

NEW SELLING AND MEASURING TECHNIQUES

New methods employed in trade (e.g. selling of pre-packaged goods) and new measurement techniques (e.g. conveyor belt weighers) sometimes necessitate permissible error limits different from those of classical mechanical instruments (e.g. the knife-edge supported balances).

TRADE PARTNERS

In the case of the classical measuring instruments, especially in retail shops, both partners of the transaction, namely the merchant and the buyer, are present at the time of the measurement being performed. In the case of prepackaged goods the buyer is not present any more when weighing is done, he can check the correctness of the quantity of the goods only subsequently. If large volumes of goods are delivered continuously between two partners, the representatives of both can be steadily present, supervising the functioning of the measuring instruments and each other's activity.

VERIFICATION PRESCRIPTIONS

Rapid technological progress requires steadily renewable and elastic verification prescriptions. It is difficult to elaborate a general prescription for a certain kind of measuring device which is applicable to all new types appearing on the market.

This implies serious difficulties in the very desirable international harmonization of national verification processes and prescriptions.

The enumerated problems deserve careful consideration. Beyond this, it should never be forgotten that official verification tries to prevent erroneous functioning and indication of measuring instruments, but can hardly prevent erroneous or unfair operation.

SUMMARY REPORT on the FIRST CARIBBEAN METROLOGY PROJECT GROUP MEETING HELD in PORT-of-SPAIN, TRINIDAD ; 23-27 APRIL 1979

by **G. SOUCH**
Head of Legal Metrology Branch
Metrology, Quality Assurance and Standards Division
Department of Trade
(Royaume-Uni de Grande-Bretagne)

INTRODUCTION

1. The successful application of science and technology for industrial development requires that a country has not only an infrastructure of education, training facilities, R and D institutions etc but also an evolving and effective measurement capability which keeps pace with expanding needs. Such a capability embraces among other things the provision of measurement standards i.e. measures of the physical quantities such as mass, length and volume, specification standards i.e. criteria against which products can be assessed for conformance, the definition of legislative controls and adequately staffed and equipped measurement facilities.

2. Measurement plays a vital role in consumer protection, quality control and assurance, certification schemes, export promotion and so on and is indispensable to the overall economic development of a country. It is natural, therefore, that emergent states seeking to develop their economies should give some priority to developing a national measurement system.

3. Overall the Caribbean Region is at a very early stage in developing its metrological facilities. In such a Region where measurement capability requirements, the rate at which individual states economies are likely to develop, and the areas of development differ greatly it is logical that they should seek a solution to the measurement capability problem on a co-operative basis.

4. The First Caribbean Metrology Project Meeting which was held in Port-of-Spain, Trinidad, was convened against this background as part of the Commonwealth Science Council (CSC) Co-ordinated Research and Development Programme

which seeks to establish collaboration among Commonwealth countries in selected fields of mutual interest. In this context the Council was acting as a catalyst in bringing together Commonwealth countries in the Region to determine their measurement capability needs, to further the development of adequate measurement competence and facilities and to foster co-operation.

About twenty member states and organisations were attending the Meeting. OIML was represented by Mr G. SOUCH the United Kingdom Member of the International Committee following an invitation received by the Bureau from CSC.

THE PROJECT GROUP MEETING.

5. Following an opening address by Senator Marilyn GORDON a Minister in the Ministry of Industry and Commerce, Trinidad and Tobago, emphasising the importance governments in the Region attached to the CSC initiative, the CSC representative Dr A. KHAN outlined the aims of the Project Group, referred to the role of CSC in furthering metrological development in emergent countries of the Commonwealth, and described the success achieved by the Asia/Pacific Meeting held in 1977. Thereafter the programme of work was conducted in plenary sessions and ad hoc working groups and included :

I) Formal statements by the national representative of each participating member state on his country's metrology status and envisaged future needs.

II) An overall review of national statements to identify Regional metrology needs in relation to the facilities available or planned in each member state for
- trade, safety and health i.e. legal metrology requirements
- industrial measurement and calibration requirements
- education and training requirements

III) The establishment of ad hoc working groups to identify and prepare project proposals relating to II) above

IV) The presentation, discussion and adoption of project proposals

V) The selection of a Steering Committee to initiate and manage approved projects.

Members of the Project Group also visited three industrial concerns (Metal Box Company, Nestle Ltd and Lever Bros) which illustrated the differing metrological capability needs of Trinidad and Tobago.

SUMMARY OF MEMBER STATES REPORTS

6. The formal statements by national representatives on the present status of measurement standards and metrology activity in their countries provided the starting point for Group discussions. These were presented in the early stages of the meeting and served to highligth areas in which help was needed and collaboration sought. the picture which emerged was one of extremes ; on the one hand there were those countries, for example Trinidad and Togabo, Jamaica, Barbados and Guyana who have established and are developing metrological services and those who have yet to identify their needs before initiating

such programmes ; in many cases the smaller countries were still dependent on extant provisions which had their origins in the Colonial past. Clearly future metrological needs within the Region will be diverse in terms of the sophistication of facilities, the location of facilities, the levels of collaboration and so on.

7. It was interesting to note that all reports placed heavy emphasis on the need for training in one field or another and many were seeking information and training in « metrication practices » ; this arose from the declared intention of all member states to move to metric measurements over a two or three year period starting in 1980-81. All countries appeared to be contemplating, or have recently completed, a major revision of their weigths and measures legislation — UK 1978 Weights and Measures Act was mentioned frequently as being the basis of their current requirements — and two countries (Barbados and Trinidad and Tobago) have recently acquired assistance in this field from UNIDO and CFTC ; Trinidad and Tobago are awaiting formal ratification in Parliament of their new Act. In this connection it was recognised by all delegates that it would be advantageous to the Region if harmonisation of legal metrology laws could be achieved at the outset through the provision of model laws, measuring equipment regulations, procedures etc and more cost effective if expensive technical resources for example such as high accuracy calibration facilities could be pooled for the common good.

8. Specific needs emphasised by delegates in their presentations, and which gave rise later to project proposals were :

I) The need for a Weights and Measures or Metrology Law in each territory ; this would assist metrication and provide a basis for consumer protection and the development of industrial metrology.

II) The need to identify a regional set of standards for the basic measurement of mass, length and volume for legal and industrial use.

III) The need for a common regional facility for the comparison and calibration of large masses (up to 1 tonne) and surveyor's tapes (up to 30 metres).

IV) The industrialised territories will need facilities for thermometry (for the control of food processing, the manufacture of plastics and metallurgy) and time/frequency measurements (for electrical power systems, telecommunications etc).

V) Standards checking procedures within the Region based on circulating test standards, test pieces and reference materials.

VI) Industrialising territories need to ensure that their manufacturers have adequate measurement facilities for design, production and quality control purposes ; some emphasis throughout the Meeting was laid on the development and introduction in Industry of quality assurance requirements and procedures.

VII) Discussion should take place on the introduction of the « average system » as opposed to the present « minimum » requirement which is enshrined in now outdated legislation and which is being phased out in metropolitan countries.

VIII) Training in metrology which is presently provided largely from outside the Region should become a Regional commitment using expertise from elsewhere ; such training should embrace not only the staff of enforcement authorities but also manufacturers and technicians providing repair and servicing facilities.

IX) Information is an essential resource ; extensive information and guidance on measuring equipment, legislation, regulations, procedures etc is available from the developed countries and international organisations such as OIML, ISO, BIPM and should be used whenever possible.

9. The need for information, technical advice and assistance in satisfying these needs was recognised by all delegates and it was noted that increasingly the International Organisations, having regard to the special problems associated with metrological development in developing countries were now generally instituting measures aimed at providing such help. In regard to the provision of model laws, specifications for equipment, organisational arrangements and procedures etc it was noted that OIML has now set up on an experimental basis a Development Council to further its work in this field of activity and that the work of many Pilot Secretariats is relevant to the needs of developing countries. A short presentation by the OIML representative on the role and functions of the Organisation with particular emphasis on the assistance which can be provided to developing countries was well received ; the presentation was also the basis of a radio interview to be included in a programme on the Project Group Meeting to be made available worldwide by the CSC Secretariat.

10. In view of the important role metrology plays in developing scientific and technological competence as well as in trade and industry the Project Group, following recommendations made by four ad hoc working groups, agreed to formulate a comprehensive metrology programme. The programme which reflects the remit of the groups will consist of the following broad areas :

I) legal metrology

II) industrial metrology

III) information

IV) training

11. The Group also developed specific project proposals in each of these areas which are listed hereafter and recommended that the programme should be launched immediately to foster regional collaboration and ensure that metrology is developed to meet the needs of different countries. To help in achieving this aim a Regional Metrology Group comprised of representatives from all participating countries is to be set up with overall responsibility for reviewing the operation of the programme and to provide linkage between participants.

12. To assist in implementing the programme it was proposed and agreed that a Steering Committee comprised of members from Trinidad, Barbados, Jamaica and Guyana —the more developed countries — with one representative from the Lesser Developed Countries (LDC), the CARICOM (*) Secretariat and the Commonwealth Science Council Secretariat should be set up ; the Chairman of the CARICOM Standards Council is to be the Chairman of the Metrology Group and the Steering Committee and will thereby act in the role of Regional Programme Co-ordinator.

(*) CARICOM - Caribbean Economic Community.

It was also suggested that the Secretary of the CARICOM Standards Council should be the Secretary of the Steering Committee and that the CARICOM Secretariat should act as the Regional Secretariat of the CSC in operating this programme ; it was proposed that the Steering Committee should meet every six months at differing venues throughout the Region. To monitor progress it is expected that a programme review meeting of representatives from all participating countries will be held early in 1981.

CONCLUSION

13. It was evident from the material presented and discussions which took place that the metrological needs of participating countries are diverse and that without exception the status of their present capability is far below what is required. However, the awareness of delegates of these shortcomings and the need to create a sound legal and industrial metrology base appropriate to their developing economies, and their willingness to co-operate, augurs well for the implementation of the metrology programme ; they have identified the problem and are now well informed on the nature and extent of it.

14. To achieve their individual and corporate objectives the participants in the programme will undoubtedly require technical advice and assistance and it is likely that they will seek financial aid from appropriate sources. Several delegates made the point that competing demands on their national finances would inevitably dictate the rate of progress ; priorities will have to be agreed individually and corporately and help sought from elsewhere including the international organisations i.e. UNIDO, UNESCO, ISO and OIML. The need for information on legal metrology requirements, procedures, regulations and equipment and industrial metrology practices including quality control and assurance in industry was emphasised by all delegates and measures are to be introduced for the collection, collation and dissemination of such information.

15. Responsibility for the pace and nature of metrology developments in the Region now lies solely with the participating countries under the guidance of the Steering Committee. In sponsoring and organising the meeting CSC has created the necessary environment and management arrangements for the development of metrology in the Region. The review meeting provisionally scheduled 18 months hence will examine progress, amend the programme if necessary and hopefully add further impetus to the work. In the interim period help and guidance will be sought from many sources ; OIML and its new Development Council will, no doubt, be able to make a useful contribution to the work now set in train in the Caribbean Region by providing information and advice on legal metrology.

1st June 1979

SPECIFIC TITLES of PROJECTS RECOMMENDED by the THREE WORKING GROUPS

Legal metrology

1. Preparation of model metrology and metrication legislation for regional use ;
2. Development of a regional legal metrology program ;
3. Appraisal and provision of metrological equipment in the territories of the region ;
4. Survey of common types of weighing and measuring equipment in use in trade in the participating territories ;

Industrial metrology

5. Compilation of the list of Metrological resources for individual Caribbean territories ;
6. Catalogue the perceived needs of industry, commerce, business, government, safety, health, environment, etc. of individual Caribbean Countries ;
7. Devise an overall system for the development of industrial metrology in the Caribbean by :
   (a) effective utilization of national metrological services on a regional basis,
   (b) acquiring and deploying additional resources for meeting perceived needs ;
8. Creation of Mechanism for providing
   (a) advice and information,
   (b) assistance on metrological problems ;
9. Thermometric standards and calibration ;
10. Time and frequency standards and calibration ;
11. Standards and calibration services for electricity, gas and water meters ;
12. Quality assurance of imported materials, components, units, and manufactured items ;
13. Quality assurance of locally manufactured goods ;
14. Harmonization of the change in method of measurement of alcohol from % proof spirit to % by volume ;

Training

15. Regional training in legal metrology ;
16. Regional training programme in industrial metrology ;
17. Assessment of metrological capabilities and needs of the region.

NOUVEAUX ETATS MEMBRES

La REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE d'une part et la REPUBLIQUE HELLENIQUE (précédemment Membre Correspondant de notre Institution) d'autre part, ont déposé le 26 juin 1979, auprès du Ministère des Affaires Etrangères de la République Française, leurs instruments d'adhésion à la Convention instituant l'Organisation Internationale de Métrologie Légale.

Les Autorités gouvernementales de l'ALGERIE et de la GRECE désigneront prochainement leurs représentants au Comité International de Métrologie Légale.

NOUVEAUX MEMBRES CORRESPONDANTS

Le Centre d'Essai et de Recherche Industrielle de la REPUBLIQUE ARABE SYRIENNE, le Ministère du Développement Economique de la REPUBLIQUE de COLOMBIE, ainsi que le Ministère des Finances et du Commerce de la REPUBLIQUE du MALI ont sollicité l'inscription de ces Pays en tant que Membres Correspondants de notre Institution.

Monsieur le Président a accepté avec plaisir ces nouvelles demandes.

ETAT EN SUSPENS

Par décision de la Commission du Budget de l'Assemblée Nationale, la REPUBLIQUE ISLAMIQUE d'IRAN n'est plus membre de notre Institution à compter du 1er janvier 1979. Nous enregistrons cette démission qui ne sera peut-être que provisoire.

MEMBRES DU COMITE

CUBA — Le Comité d'Etat de Normalisation de la REPUBLIQUE de CUBA nous a informé du remplacement de Monsieur MIRANDA GONZALEZ à la direction du Centre de Recherches Métrologiques par Monsieur J. OCEGUERA qui représentera son Pays au Comité International de Métrologie Légale.

INDE — Monsieur K. VENKATESWARAN, Directeur des Poids et Mesures nous a fait connaître son départ de la direction de ce Service. Le successeur de Monsieur VENKATESWARAN au Comité International de Métrologie Légale sera prochainement désigné.

INDONESIE — Monsieur MARTOYO, appelé à de nouvelles fonctions, nous a informé de son départ de la Direction de Métrologie. Son successeur, membre du Comité International de Métrologie Légale, sera prochainement désigné.

VENEZUELA — Monsieur R. de COLUBI CHANEZ nous a averti de son départ à la retraite qui achève une confiante et amicale collaboration internationale de dix-neuf ans au sein de notre Comité. Nous lui souhaitons une heureuse et prospère retraite.

Le Gouvernement Venezuelien a désigné, pour lui succéder à la Direction du Service National de Métrologie Légale, Monsieur A. PEREZ GUANCHEZ qui devient également Représentant de son Pays au Comité International de Métrologie Légale.

Il nous reste à renouveler nos remerciements pour l'aide fructueuse que MM. MIRANDA GONZALEZ, VENKATESWARAN, MARTOYO et COLUBI CHANEZ ont bien voulu nous accorder. Que leurs successeurs reçoivent parmi nous la meilleure bienvenue.

PROCHAINES REUNIONS

	Groupes de travail	Dates	Lieux
SP.7 - Sr.4	Instruments de pesage à fonctionnement non automatique	18-20 septembre 1979	BRAUNSCHWEIG
SP.18 - Sr.1	Humidimètres pour grains de céréales et graines oléagineuses	2-4 octobre 1979	PARIS
SP.26	Instruments de mesurage utilisés dans le domaine de la santé publique	23-26 octobre 1979	BRAUNSCHWEIG
SP.5 - Sr.16	Compteurs d'eau	25-26 octobre 1979	TEL AVIV
SP.5 - Sr.20	Méthodes et dispositifs de vérification des instruments de mesurage de liquides	8-9 novembre 1979	TOKYO
SP.25 - Sr.3	Matériel nécessaire pour le fonctionnement d'un Service national de métrologie légale	13-16 novembre 1979	RIGA
SP.5 - Sr.13 et 19	Compteurs de liquides autres que l'eau à chambres mesureuses et à turbine. Dispositifs électroniques appliqués au mesurage des quantités de liquides	début 1980 (*provisoire*)	——
SP.1	Terminologie	début 1980 (*provisoire*)	——
SP.1 - Sr.1	Vocabulaire de Métrologie légale Termes fondamentaux		
SP.1 - Sr.2	Vocabulaire des divers domaines de mesurage		
——	Groupe ad hoc Marque OIML	19-21 mars 1980	B.I.M.L.
SP.23 - Sr.1 à 5	Méthodes et moyens d'attestation des dispositifs de vérification	24-28 mars 1980	B.I.M.L
SP.22 et	Principes du contrôle métrologique	31 mars 1-2 avril 1980	B.I.M.L.
SP.22 - Sr.6	Principes permettant d'assurer l'efficacité du contrôle métrologique		
SP.26 - Sr.4	Instruments de mesure bio-électriques	31 mars - 4 avril 1980	KISLOVODSK

SP.21 - Sr.1	Caractéristiques métrologiques normalisées des instruments de mesurage lors du mesurage des quantités constantes dans le temps	**21-25 avril 1980** *(provisoire)*	KRASNODAR
SP.21 - Sr.2	Caractéristiques métrologiques normalisées des instruments de mesurage lors du mesurage des quantités variables dans le temps		
SP.12 - Sr.8	Compteurs d'énergie thermique	**20-22 mai 1980**	MUNICH
SP.12 - Sr.1	Terminologie (températures et énergie calorifique)	**août 1980** *(provisoire)*	GRANDE-BRETAGNE
SP.21 - Sr.4	Caractéristiques métrologiques normalisées des systèmes de mesurage	**22-26 septembre 1980**	VILNIUS
SP.21 - Sr.5	Méthodes du contrôle des caractéristiques métrologiques des instruments de mesurage		
SP.2 - Sr.2	Unités	**23-25 septembre 1980**	VIENNE
SP.27	Principes généraux de l'utilisation des matières de référence en métrologie légale	**20-25 octobre 1980**	TBILISSI
SP.27 - Sr.1	Terminologie		
SP.27 - Sr.3	Propriétés métrologiques des matières de référence et leur normalisation		
SP.27 - Sr.5	Principes d'utilisation des matières de référence		
SP.31	Enseignement de la métrologie	**24-28 novembre 1980**	TACHKENT
SP.7	Mesurage des masses	**courant 1980** *(provisoire)*	WASHINGTON
SP.9 - Sr.5	Pycnomètres	**courant 1980** *(provisoire)*	PARIS

Conseil de la Présidence	**25-27 sept. 1979**	B.I.M.L.
Sixième Conférence Internationale de Métrologie Légale	**16-20 juin 1980**	WASHINGTON
Dix-septième Réunion du Comité International de Métrologie Légale	**16 juin 1980**	WASHINGTON

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Section II - Mesure des radionucléides
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Section III - Mesures neutroniques
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Gost 8.335-78 : Hardness standard blocks. Methods and means for verification

Gost 8.337-78 : Measuring converters. Instruments shunts. Methods and means of verification

Gost 8.338-78 : Thermotransducers of technical thermoelectrical thermometers. Methods and means of verification

Gost 8.340-78 : Dead-weight testers type MP-0,4. Methods and means of verification

Gost 8.341-79 : Low-pressuse pneumatic length gages. Methods and means for verification

Gost 8.343-79 : Air electrical transducers. Methods and means of verification

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de la

CONFERENCE INTERNATIONALE DE METROLOGIE LEGALE

R.I. N°		SECRETARIATS	Année d'édition
	— Vocabulaire de métrologie légale (termes fondamentaux) (édition bilingue français/anglais)	**Pologne**	**— 1978**
1 —	Poids cylindriques de 1 gramme à 10 kilogrammes (de la classe de précision moyenne)	**Belgique**	**— 1973**
2 —	Poids parallélépipédiques de 5 à 50 kilogrammes (de la classe de précision moyenne)	**Belgique**	**— 1973**
3 —	Réglementation métrologique des instruments de pesage à fonctionnement non automatique	**R.F. d'Allemagne et France**	**— 1978**
4 —	Fioles jaugées (à un trait) en verre	**Gde-Bretagne**	**— 1970**
5 —	Compteurs de volume de liquides (autres que l'eau) à chambres mesureuses	**R.F. d'Allemagne et France**	**— 1970**
6 —	Prescriptions générales pour les compteurs de volume de gaz	**Pays-Bas et R.F. d'Allemagne**	**— 1978**
7 —	Thermomètres médicaux à mercure, en verre, avec dispositif à maximum	**R.F. d'Allemagne**	**— 1978**
8 —	Méthode étalon de travail destinée à la vérification des instruments de mesurage du degré d'humidité des grains	**R.F. d'Allemagne**	**— 1970**
9 —	Vérification et étalonnage des blocs de référence de dureté Brinell	**Autriche**	**— 1970**
10 —	de dureté Vickers		
11 —	de dureté Rockwell B		
12 —	de dureté Rockwell C		
13 —	Symbole de correspondance	**B.I.M.L.**	**— 1970**
14 —	Saccharimètres polarimétriques	**R.F. d'Allemagne**	**— 1978**

15 —	Instruments de mesure de la masse à l'hectolitre des céréales	**R.F. d'Allemagne**	**— 1970**
16 —	Manomètres des instruments de mesure de la tension artérielle	**Autriche**	**— 1970**
17 —	Manomètres - manovacuomètres - vacuomètres « indicateurs » à éléments récepteurs élastiques à indications directes par aiguille et échelle graduée (catégorie instruments de travail)	**U.R.S.S.**	**— 1970**
18 —	Pyromètres optiques à filament disparaissant	**U.R.S.S.**	**— 1970**
19 —	Manomètres - manovacuomètres - vacuomètres « enregistreurs » à éléments récepteurs élastiques à enregistrements directs par style et diagramme (catégorie instruments de travail)	**U.R.S.S.**	**— 1970**
20 —	Poids des classes de précision E_1 E_2 F_1 F_2 M_1 de 50 kg à 1 mg	**Belgique**	**— 1973**
21 —	Taximètres	**R.F. d'Allemagne**	**— 1973**
22 —	Alcoométrie	**France**	**— 1973**
—	Tables alcoométriques	**France**	**— 1975**
23 —	Manomètres pour pneumatiques	**U.R.S.S.**	**— 1973**
24 —	Mètre étalon rigide pour Agents de Vérification	**Inde**	**— 1973**
25 —	Poids étalons pour Agents de vérification	**Inde**	**— 1977**
26 —	Seringues médicales	**Autriche**	**— 1973**
27 —	Compteurs de volume de liquides autres que l'eau — Dispositifs complémentaires	**R.F. d'Allemagne et France**	**— 1973**
28 —	Réglementation « technique » des instruments de pesage à fonctionnement non-automatique	**R.F. d'Allemagne et France**	**— 1973**
29 —	Mesures de capacité de service	**Suisse**	**— 1973**
30 —	Mesures de longueur à bouts plans	**U.R.S.S.**	**— 1973**
31 —	Compteurs de volume de gaz à parois déformables	**Pays-Bas**	**— 1973**
32 —	Compteurs de volume de gaz à pistons rotatifs et compteurs de volume de gaz à turbine	**R.F. d'Allemagne**	**— 1973**
33 —	Valeur conventionnelle du résultat des pesées dans l'air	**B.I.M.L.**	**— 1973**
34 —	Classes de précision des instruments de mesurage	**U.R.S.S.**	**— 1974**

35 —	Mesures matérialisées de longueur pour usages généraux	**Belgique et Hongrie**	**— 1977**
36 —	Vérification des pénétrateurs des machines d'essai de dureté	**Autriche**	**— 1977**
37 —	Vérification des machines d'essai de dureté système Brinell	**Autriche**	**— 1977**
38 —	Vérification des machines d'essai de dureté système Vickers	**Autriche**	**— 1977**
39 —	Vérification des machines d'essai de dureté système Rockwell B,F,T — C,A,N	**Autriche**	**— 1977**
40 —	Pipettes étalons pour Agents de vérification	**Inde**	**— 1977**
41 —	Burettes étalons pour Agents de vérification	**Inde**	**— 1977**
42 —	Poinçons de métal pour Agents de vérification	**Inde**	**— 1977**
43 —	Fioles étalons graduées en verre pour Agents de vérification	**Inde**	**— 1977**
44 —	Alcoomètres et aréomètres pour alcool	**France**	**— 1977**
45 —	Tonneaux et futailles	**Autriche**	**— 1977**
46 —	Compteurs d'énergie électrique active à branchement direct	**France**	**— 1978**
47 —	Poids étalons pour le contrôle des instruments de pesage de portée élevée	**R.F. d'Allemagne et France**	**— 1978**
48 —	Lampes à ruban de tungstène pour l'étalonnage des pyromètres optiques	**U.R.S.S.**	**— 1978**
49 —	Compteurs d'eau (destinés au mesurage de l'eau froide)	**Gde-Bretagne**	**— 1977**

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D.I. N°

1 —	Loi de métrologie	**BIML**	**— 1975**
2 —	Unités de mesures légales	**BIML**	**— 1978**
3 —	Qualification légale des instruments de mesurage	**BIML**	**— 1979**

Note - Recommandations internationales et Documents internationaux peuvent être acquis au Bureau International de Métrologie Légale.

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