

**Bureau International des Poids et Mesures**

# **Comité International des Poids et Mesures**

89th meeting (October 2000)

#### Note on the use of the English text

To make its work more widely accessible the Comité International des Poids et Mesures publishes an English version of its reports.

Readers should note that the official record is always that of the French text. This must be used when an authoritative reference is required or when there is doubt about the interpretation of the text.

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**MEMBER STATES OF THE METRE CONVENTION AND  
ASSOCIATES OF THE CONFÉRENCE GÉNÉRALE**

as of 19 October 2000

**Member States of the Metre Convention**

Argentina	Japan
Australia	Korea (Dem. People's Rep. of)
Austria	Korea (Rep. of)
Belgium	Mexico
Brazil	Netherlands
Bulgaria	New Zealand
Cameroon	Norway
Canada	Pakistan
Chile	Poland
China	Portugal
Czech Republic	Romania
Denmark	Russian Federation
Dominican Republic	Singapore
Egypt	Slovakia
Finland	South Africa
France	Spain
Germany	Sweden
Hungary	Switzerland
India	Thailand
Indonesia	Turkey
Iran (Islamic Rep. of)	United Kingdom
Ireland	United States
Israel	Uruguay
Italy	Venezuela

**Associates of the Conférence Générale**

Hong Kong, China

## THE BIPM AND THE METRE CONVENTION

The Bureau International des Poids et Mesures (BIPM) was set up by the Metre Convention signed in Paris on 20 May 1875 by seventeen States during the final session of the diplomatic Conference of the Metre. This Convention was amended in 1921.

The BIPM has its headquarters near Paris, in the grounds (43 520 m<sup>2</sup>) of the Pavillon de Breteuil (Parc de Saint-Cloud) placed at its disposal by the French Government; its upkeep is financed jointly by the Member States of the Metre Convention.

The task of the BIPM is to ensure worldwide unification of physical measurements; its function is thus to:

- establish fundamental standards and scales for the measurement of the principal physical quantities and maintain the international prototypes;
- carry out comparisons of national and international standards;
- ensure the coordination of corresponding measurement techniques;
- carry out and coordinate measurements of the fundamental physical constants relevant to these activities.

The BIPM operates under the exclusive supervision of the Comité International des Poids et Mesures (CIPM) which itself comes under the authority of the Conférence Générale des Poids et Mesures (CGPM) and reports to it on the work accomplished by the BIPM.

Delegates from all Member States of the Metre Convention attend the General Conference which, at present, meets every four years. The function of these meetings is to:

- discuss and initiate the arrangements required to ensure the propagation and improvement of the International System of Units (SI), which is the modern form of the metric system;
- confirm the results of new fundamental metrological determinations and various scientific resolutions of international scope;
- take all major decisions concerning the finance, organization and development of the BIPM.

The CIPM has eighteen members each from a different State: at present, it meets every year. The officers of this committee present an annual report on the administrative and financial position of the BIPM to the Governments of

the Member States of the Metre Convention. The principal task of the CIPM is to ensure worldwide uniformity in units of measurement. It does this by direct action or by submitting proposals to the CGPM.

The activities of the BIPM, which in the beginning were limited to measurements of length and mass, and to metrological studies in relation to these quantities, have been extended to standards of measurement of electricity (1927), photometry and radiometry (1937), ionizing radiation (1960), time scales (1988) and to chemistry (2000). To this end the original laboratories, built in 1876-1878, were enlarged in 1929; new buildings were constructed in 1963-1964 for the ionizing radiation laboratories and in 1984 for the laser work. In 1988 a new building for a library and offices was opened.

Some forty-five physicists and technicians work in the BIPM laboratories. They mainly conduct metrological research, international comparisons of realizations of units and calibrations of standards. An annual report, the *Director's Report on the Activity and Management of the Bureau International des Poids et Mesures*, gives details of the work in progress.

Following the extension of the work entrusted to the BIPM in 1927, the CIPM has set up bodies, known as Consultative Committees, whose function is to provide it with information on matters that it refers to them for study and advice. These Consultative Committees, which may form temporary or permanent working groups to study special topics, are responsible for coordinating the international work carried out in their respective fields and for proposing recommendations to the CIPM concerning units.

The Consultative Committees have common regulations (*BIPM Proc.-Verb. Com. Int. Poids et Mesures*, 1963, **31**, 97). They meet at irregular intervals. The chairman of each Consultative Committee is designated by the CIPM and is normally a member of the CIPM. The members of the Consultative Committees are metrology laboratories and specialized institutes, agreed by the CIPM, which send delegates of their choice. In addition, there are individual members appointed by the CIPM, and a representative of the BIPM (Criteria for membership of Consultative Committees, *BIPM Proc.-Verb. Com. Int. Poids et Mesures*, 1996, **64**, 124). At present, there are ten such committees:

1. The Consultative Committee for Electricity and Magnetism (CEM), new name given in 1997 to the Consultative Committee for Electricity (CCE) set up in 1927;



2. The Consultative Committee for Photometry and Radiometry (CCPR), new name given in 1971 to the Consultative Committee for Photometry (CCP) set up in 1933 (between 1930 and 1933 the CCE dealt with matters concerning photometry);
3. The Consultative Committee for Thermometry (CCT), set up in 1937;
4. The Consultative Committee for Length (CCL), new name given in 1997 to the Consultative Committee for the Definition of the Metre (CCDM), set up in 1952;
5. The Consultative Committee for Time and Frequency (CCTF), new name given in 1997 to the Consultative Committee for the Definition of the Second (CCDS) set up in 1956;
6. The Consultative Committee for Ionizing Radiation (CCRI), new name given in 1997 to the Consultative Committee for Standards of Ionizing Radiation (CCEMRI) set up in 1958 (in 1969 this committee established four sections: Section I (X- and  $\gamma$ -rays, electrons), Section II (Measurement of radionuclides), Section III (Neutron measurements), Section IV ( $\alpha$ -energy standards); in 1975 this last section was dissolved and Section II was made responsible for its field of activity);
7. The Consultative Committee for Units (CCU), set up in 1964 (this committee replaced the “Commission for the System of Units” set up by the CIPM in 1954);
8. The Consultative Committee for Mass and Related Quantities (CCM), set up in 1980;
9. The Consultative Committee for Amount of Substance (CCQM), set up in 1993;
10. The Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV), set up in 1999.

The proceedings of the General Conference, the CIPM and the Consultative Committees are published by the BIPM in the following series:

- *Comptes Rendus des Séances de la Conférence Générale des Poids et Mesures;*
- *Procès-Verbaux des Séances du Comité International des Poids et Mesures;*
- *Reports of Meetings of Consultative Committees.*

The BIPM also publishes monographs on special metrological subjects and, under the title *Le Système International d'Unités (SI)*, a brochure, periodically updated, in which are collected all the decisions and recommendations concerning units.

The collection of the *Travaux et Mémoires du Bureau International des Poids et Mesures* (22 volumes published between 1881 and 1966) and the *Recueil de Travaux du Bureau International des Poids et Mesures* (11 volumes published between 1966 and 1988) ceased by a decision of the CIPM.

The scientific work of the BIPM is published in the open scientific literature and an annual list of publications appears in the *Director's Report on the Activity and Management of the Bureau International des Poids et Mesures*.

Since 1965 *Metrologia*, an international journal published under the auspices of the CIPM, has printed articles dealing with scientific metrology, improvements in methods of measurement, work on standards and units, as well as reports concerning the activities, decisions and recommendations of the various bodies created under the Metre Convention.

## **CURRENT MEMBERS OF THE COMITÉ INTERNATIONAL DES POIDS ET MESURES**

as of 19 October 2000

### **President**

1. J. Kovalevsky, President of the Bureau National de Métrologie, Observatoire de la Côte d'Azur, avenue N. Copernic, 06130 Grasse, France.

### **Secretary**

2. R. Kaarls, Klaverwydenstraat 13, 2381 VX Zoeterwoude, The Netherlands.

### **Members**

3. K.H. Brown, Deputy Director, National Institute of Standards and Technology, Gaithersburg, MD 20899-1000, United States.
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6. E.O. Göbel, President, Physikalisch-Technische Bundesanstalt, Postfach 3345, D-38023 Braunschweig, Germany.
7. E.S.R. Gopal, Emeritus scientist, Department of Physics, Indian Institute of Science, Bangalore 560 012, India.
8. K. Iizuka, c/o National Research Laboratory of Metrology, 1-1-4 Umezono, Tsukuba 305, Japan. *Vice-president*.
9. B. Inglis, Director, National Measurement Laboratory, CSIRO, P.O. Box 218, Lindfield NSW 2070, Australia.
10. L.K. Issaev, Deputy Director, VNIIMS, Gosstandart of Russia, Leninsky prospect 9, 117049 Moscow, Russian Fed..
11. S. Leschiutta, President, Istituto Elettrotecnico Nazionale Galileo Ferraris, Corso Massimo d'Azeglio 42, I-10125 Turin, Italy.
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16. R. VanKoughnett, 58 Centrepark Drive, Gloucester ON, K1B 3C1, Canada. *Vice-president*.
17. A.J. Wallard, Deputy Director, National Physical Laboratory, Teddington TW11 0LW, United Kingdom.
18. . . .

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6. D. Kind, Knappstrasse 4, 38116 Braunschweig, Germany.
7. H. Preston-Thomas, 1109 Blasdell Avenue, Ottawa K1K 0C1, Canada.
8. J. Skákala, Professor, Slovak Technical University, Nám. Slobody 17, 812 31 Bratislava, Slovakia.

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BUREAU INTERNATIONAL DES POIDS ET MESURES**

on 1 January 2001

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Mrs A. Chartier, Mr J. Labot

**Mass:** Dr R.S. Davis

Dr H. Fang\*, Mrs C. Goyon-Taillade, Mr A. Picard, Dr L.F. Vitushkin  
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**Electricity:** Dr T.J. Witt

Mr F. Delahaye, Dr D. Reymann  
Mr D. Avrons, Mr R. Chayramy, Mr A. Jaouen

**Radiometry and photometry:** Dr R. Köhler

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**Ionizing radiation:** Dr P. Allisy-Roberts

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Mr C. Colas, Mr M. Nonis, Mr P. Roger, Mr C. Veyradier

**Chemistry:** Dr R. Wielgosz

**Publications:** Prof. P.W. Martin

Dr J.R. Miles

**BIPM key comparison database:** Dr C. Thomas\*\*

**Secretariat:** Mrs F. Joly

Mrs L. Delfour, Mrs D. Le Coz\*\*, Mrs G. Negadi

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Mrs D. Spelzini Etter, Mrs M.-J. Martin, Mrs D. Saillard\*\*

*Caretakers:* Mr and Mrs Dominguez, Mr and Mrs Neves

*Domestic help:* Mrs R. Prieto, Mrs R. Vara

*Gardeners:* Mr C. Dias-Nunes, Mr A. Zongo\*\*\*

**Workshop:** Mr J. Sanjaime

Mr P. Benoit, Mr F. Boyer, Mr M. de Carvalho, Mr J.-B. Caucheteux,

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Mr E. Dominguez\*\*\*\*, Mr C. Neves \*\*\*\*

**Director emeritus:** Prof. P. Giacomo

**Principal Metrologist emeritus:** Mr G. Leclerc

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\*\*\* Also Workshop.

\*\*\*\* Also caretaker.

**Comité International  
des Poids et Mesures**

**Proceedings of the sessions  
of the 89th meeting**  
(19–20 October 2000)

## Agenda

- 1 Opening of the meeting; quorum; agenda.
- 2 Report of the Secretary and activities of the bureau of the CIPM (October 1999 – September 2000).
- 3 Nomination of the next Director of the BIPM.
- 4 Membership of the CIPM.
- 5 The Mutual Recognition Arrangement.
- 6 Consultative Committees:
  - CCU;
  - CCEM;
  - CCQM;
  - CCT;
  - CCL;
  - CCAUV;
  - CCM;
  - CCTF;
  - CCPR;
  - CCRI;
  - *Ad hoc* Working Group on Viscosity;
  - Working Group on Gravimetry;
  - Membership of Consultative Committees;
  - Future meetings.
- 7 Metre Convention/OIML Joint Working Group.
- 8 Work of the BIPM:
  - Director's Report and presentation of the scientific work by the staff of the BIPM;
  - Installation of the new BIPM Chemistry section;
  - Tour of the new building;
  - Depository of the metric prototypes.



- 9 Administrative and financial affairs:
  - Administrative and financial affairs;
  - Staff Statutes;
  - Promotions.
- 10 New study of future needs for metrology.
- 11 Other business.
- 12 Date of next meeting.

**1 OPENING OF THE MEETING;  
QUORUM;  
AGENDA**

The International Committee for Weights and Measures (Comité International des Poids et Mesures, CIPM) held its 89th meeting on Thursday 19 and Friday 20 October 2000 at the Pavillon de Breteuil, Sèvres.

Present: Mrs K.H. Brown, Messrs Chung Myung Sai, Gao Jie, E.O. Göbel (on 19 October), E.S.R. Gopal, K. Iizuka, B. Inglis, L.K. Issaev, R. Kaarls, J. Kovalevsky, S. Leschiutta, G. Moscati, P. Pâquet, T.J. Quinn (Director of the BIPM), H. Ugur, J. Valdés, R. VanKoughnett and A.J. Wallard.

Also attending: Prof. P. Giacomo (Director emeritus of the BIPM), Prof. D. Kind (honorary member of the CIPM), Prof. I.M. Mills (President of the Consultative Committee for Units, on 19 October), and Mrs F. Joly and Dr J.R. Miles (secretariat).

Prof. Kovalevsky, President of the CIPM, opened the 89th meeting by welcoming all those present, and in particular Prof. D. Kind and the two new members: Dr Brown and Dr Inglis.

He noted that, all members being present, the quorum of the Committee was satisfied according to Article 12 of the Rules annexed to the Metre Convention.

He announced with regret that Prof. W. Kersten, Honorary Member of the CIPM and former President of the Physikalisch-Technische Bundesanstalt (PTB, Germany), had passed away in August 1999. Prof. Göbel added that Prof. Kersten had been in good health until a couple of years ago, and died at the age of ninety-three.

The agenda for the meeting was adopted, noting that discussion about the nomination of the new Director would take place immediately after the Secretary's report, and that Dr Iizuka would report on a meeting of the chairmen of the CCM working groups under item 6.7.

Dr Iizuka said that the Japanese Government wished to present a porcelain dish to the BIPM, and that this presentation would take place at a reception hosted that evening (19 October) by the Japanese Ambassador at his residency. Dr Quinn announced that Mr J.-P. Richer, Préfet des Hauts-de-Seine, would be joining the Committee for lunch later in the day (19 October). During a brief session of the Committee just before lunch, in the presence of

Mr Richer, both the President and Dr Quinn thanked him for the help he had given during the process of obtaining planning permission for the new building, construction of which is under way. The President then invited the Secretary of the Committee, Dr Kaarls, to present his report.

## **2 REPORT OF THE SECRETARY AND ACTIVITIES OF THE BUREAU OF THE CIPM (October 1999 – September 2000)**

Note that all the important matters arising in the report of the secretary are taken up later in the meeting and references to the later discussion are given.

The bureau of the CIPM met three times during the year, twice at the Pavillon de Breteuil and once in Sydney (Australia), on 20 May 2000, following the Conference on Precision Electromagnetic Measurements (CPEM). To celebrate the 125th anniversary of the Metre Convention, a reception was held on the latter occasion at the Sydney Observatory. In addition, the Secretary of the CIPM and the Director of the BIPM gave special lectures during the CPEM.

### **2.1 Member States of the Metre Convention**

The number of Member States of the Metre Convention remains unchanged at forty-eight. Following the decision of the CIPM in 1999 concerning non-paying Member States, letters were written to the Embassies in Paris of the Dominican Republic and Iran informing them that they will be excluded from the Convention unless arrangements can be made for the payment of overdue contributions. The letters were sent on 6 April 2000 but no replies have yet been received.

In accordance with an agreement made with Cameroon in 1998-1999 for repayment of its arrears over a ten-year period, payments have started and we should now consider Cameroon an active Member State of the Convention. Pakistan has paid most of its outstanding arrears and is also once again an active Member State. As a result of these and other payments of arrears made

since October 1999, the Notification for 2001 includes repayments to Member States amounting to some 5 % of the total dotation.

## **2.2 Membership and officers of the CIPM**

Two elections to the CIPM have been made since October 1999 to fill the vacancies left by the resignations of Bill Blevin, Katharine Gebbie and Olli Lounasmaa announced immediately after the 21st CGPM. The new members are Karen Brown (Deputy Director of the NIST, United States) and Barry Inglis (Director of the National Measurement Laboratory, CSIRO, Australia). There thus remains one vacancy on the CIPM.

The bureau has continued to seek suitable candidates for membership of the CIPM and invites members of the CIPM and other persons to submit the names and curricula vitae of suitable candidates to the Committee. The policy of the CIPM in relation to elections and details of how to apply are given on the BIPM website.

Kozo Iizuka (Vice-President of the CIPM) has informed the bureau that he intends to retire from the CIPM on 30 June 2001. The CIPM will thus have to consider the election of a Vice-President to replace him in addition to the election of a new member of the CIPM who, following the CIPM policy, will be from Japan.

The bureau has considered the consequences for appointment of persons having a double nationality. If a potential member of the CIPM or a candidate for the post of Director has a dual nationality, the CIPM will be asked, with the agreement of the candidate, to decide on the nationality on the basis of which the potential member or candidate will be appointed. This issue is discussed further under item 11 of the agenda.

## **2.3 The next director of the BIPM**

The Search Committee, established by the CIPM in October 1999 to seek and propose to the Committee one or more candidates for the post of Director of the BIPM, has carried out its task and a list of three names has been submitted to the CIPM for decision at the 2000 meeting. (Note: At the very last moment one of these three candidates has withdrawn his candidature). A separate report from the Search Committee will be submitted to the CIPM under item 3.

## **2.4 The Mutual Recognition Arrangement**

The bureau has been kept informed of the progress in the implementation of the Mutual Recognition Arrangement (MRA), including the meetings of the Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB) and establishment of the BIPM key comparison database. Under item 5 of the agenda the Director of the BIPM will report on the 5th meeting of the JCRB that took place at the Pavillon de Breteuil from 11 to 13 October 2000.

## **2.5 Associates of the CGPM**

To date, only Hong Kong, China, has completed the formalities to become an Associate of the CGPM. The bureau had to decide the annual fee for Hong Kong, China, since it is not a member of the United Nations and no corresponding contribution is available. After discussion we agreed to ask for a sum equal to 0.23 % of the BIPM annual dotation. This figure, which was accepted by the Hong Kong authorities, was arrived at by considering principally that of China (1.49 %) but also taking note of the contributions of some other States in that region. Following a preliminary approach from Chinese Taipei, the bureau (for the same reasons) fixed a sum of 0.4 %. For Chinese Taipei no formal application has yet been received. Discussions are in progress with a number of other States but it seems that it takes some time for the appropriate government or other official bodies to make a decision, despite the enthusiastic support of the local national metrology institute.

The Director has written a note on the alternatives of becoming a Member State of the Metre Convention or an Associate of the CGPM. This document has been widely distributed and is available from the BIPM website.

## **2.6 125th Anniversary of the Metre Convention**

The bureau discussed the details of the celebrations, which took place during the week of the CIPM, to mark the 125th anniversary of the Metre Convention.

As part of these celebrations the CIPM and the French Académie des Sciences jointly hosted a one-day symposium at the Académie on Tuesday 17 October 2000, featuring eight presentations on progress in metrology. The eight speakers included five Nobel Prize laureates: Prof. Steve Chu, Prof. Claude Cohen-Tannoudji, Dr Bill Phillips, Prof. Norman Ramsey and Prof. Klaus von Klitzing, and in addition Prof. Christian Bordé, Prof. Ernst

Göbel, and Prof. Sigfrido Leschiutta. At a session of the Académie on the previous day, the Nobel laureates were presented to the Académie and Prof. Jean Kovalevsky (Member of the Académie) and Dr Terry Quinn each gave a short talk on matters related to the Metre Convention and metrology.

## **2.7 BIPM/OIML/ILAC discussions**

A meeting of the joint BIPM/OIML/ILAC discussion group took place at the Pavillon de Breteuil on 23 February 2000. Among the activities proposed for the group were the following.

### **2.7.1 Model law relating to traceability of measurements to be included in the OIML basic draft law for metrology**

It was agreed that the development of a common text on traceability is an important activity and that Mr Athané should call a meeting of representatives of the three organizations for a preliminary discussion. The preparation of a legal text should await approval of the three organizations on the general question of an agreed text on traceability applicable not only to legal matters; no meeting has been called to date.

### **2.7.2 A study of the economic and social benefits of metrology**

It was agreed that such a study is beyond the resources of the organizations represented but that the results of studies already carried out, mostly by national metrology institutes, should be collated and a list of references drawn up. Attention was drawn to recent NIST studies and to an EC study soon to be published; the subject was also addressed at the meeting of directors of national metrology institutes on 18 October 2000.

### **2.7.3 A second symposium on the role of metrology in economic and social development**

Following the success of the meeting entitled “The role of metrology in economic and social development”, organized jointly by the BIPM, the IMEKO, OIML and the PTB, and held at the PTB in June 1998, the discussion group decided that a second symposium on the same subject should be arranged. T.J. Quinn agreed to contact Dr K. Brown, Deputy Director of the

NIST to suggest that the NIST, in collaboration with the PTB and with the participation of ILAC, IMEKO, OIML and the BIPM, organize the second symposium at the NIST in 2001. An immediate favourable response was obtained from Dr Brown.

#### **2.7.4 The ILAC Mutual Recognition Arrangement**

The bureau discussed matters relating to ILAC, in particular with respect to the ILAC Mutual Recognition Arrangement (which is expected to be signed soon), the ISO/IEC standard 17025 and related ILAC documents, and the importance of accredited calibration laboratories as part of a national metrology infrastructure. These matters will be discussed further with ILAC during the next ILAC General Assembly and in the next meeting in February 2001 of the BIPM with ILAC and OIML.

### **2.8 BIPM matters**

#### **2.8.1 The new building for workshop, offices and meeting rooms**

Work began on 29 January 2000 and a formal launch of the project took place during the meeting of the bureau on 22 February when the President took a hammer to the wall of the neutron building to signal its imminent demolition. Building is progressing well and is expected to be completed on schedule in May 2001.

The overall cost is now estimated to be about 20 millions French francs, which is 1.5 million French francs more than the figure presented to the Committee in October 1999. This additional cost is almost wholly due to an underestimate by the architect of one item. Although the additional cost is regrettable, it has no effect on the 1999/2000 budget because sufficient funds were already available in the special building fund (Account V).

#### **2.8.2 Contacts with the World Meteorological Organization**

Following an exchange of letters with the Chairman of the Intergovernmental Panel on Climate Change (IPCC), the Director and the new Head of the BIPM Chemistry section will visit the Headquarters of the World Meteorological Organization (WMO) in Geneva in November 2000. The purpose of the visit is to make contact with the part of the WMO already engaged in standards for

atmospheric chemistry in order to make sure that the efforts of the BIPM, the CCQM and the WMO are coordinated appropriately.

#### 2.8.3 World Trade Organization Committee on Technical Barriers to Trade

Following discussions within the bureau of the Committee and preliminary contacts with the Secretary of the World Trade Organization Committee on Technical Barriers to Trade during the discussions that led to the MRA, a formal request for Observer status was made by the BIPM in 2000. No final response has yet been received.

#### 2.8.4 International Earth Rotation Service

Following a reorganization of the structure and activities of the International Earth Rotation Service (IERS), the BIPM applied, in partnership with the US Naval Observatory (USNO), to operate the new IERS Centre for Conventions. The application was accepted; the new activity is closely related to that already carried out in respect of reference systems for space and time and provides a useful complement to our activities. No additional costs or new staff are implied by this activity.

#### 2.8.5 BIPM staff

##### *Promotions*

The CIPM is asked to approve the promotion to *Physicien principal* of Mr J. Azoubib and Dr W. Lewandowski, both of the Time section. Curricula vitae will be presented to the Committee. The CIPM was informed of the appointment of Dr R. Wielgosz as Head of the Chemistry section and is asked to confirm his nomination to the grade of *Chimiste principal*; his curriculum vitae will also be provided.

##### *Pension fund*

Under item 9 of the agenda the Committee will be asked to approve modifications to the BIPM pension fund (a) to improve the leaving allowance for staff who leave the BIPM before having the seven years service required to qualify for a pension and (b) to allow the inward and outward transfer of pension rights of staff who leave before reaching retirement age or who come



to the BIPM in mid-career. In both of these matters the proposals bring the BIPM close to what already exists in the coordinated international organizations. The Director has presented to the bureau the results of an interim study of the BIPM pension fund made by Mrs Perent. She compared the forecasts made by the actuary in 1994 with the present situation. The satisfactory result is that the pension fund in January 2000 was very close to the forecast in respect of pension payments and capital sum in the pension scheme. There are more pensioners at present than were forecast for this time, because several members of staff have chosen to retire at the age of sixty or below whereas in 1994 a retirement age of sixty-five was assumed. However, these early retirements have had little financial impact. The bureau is of the opinion that in the light of this interim study it is not necessary to embark on a new actuarial study of the pension fund at this stage. However, it may be useful to have a study carried out before the CGPM in 2003. Since it was agreed by the CIPM in 1994 that such a study should be carried out in 1999, the Committee will be asked to approve this conclusion.

*List of titles*

The CIPM will be asked to approve a revised list of titles in the statutes to take account of the recruitment of chemists.

## **2.9 Name of the Consultative Committee for Amount of Substance**

The bureau, after definitive consultation of the Consultative Committee for Amount of Substance (CCQM), is considering a possible new name for the CCQM, in order to enlarge the visibility of the CCQM and to make the scope of the Consultative Committee more clear to the outside world. The CIPM is asked to express an opinion on a change in name to Consultative Committee on Metrology in Chemistry.

**2.10 Financial report**

The table below shows the situation of the assets of the BIPM, in gold francs, on 1 January of the year noted at the head of each column.

Account	1997	1998	1999	2000
I. Ordinary funds	23 662 921.48	23 990 225.29	18 494 175.33	22 742 765.80
II. Pension fund	24 823 425.05	26 652 840.07	27 359 350.60	29 090 575.69
III. Special fund for the improvement of scientific equipment	113 004.08	115 883.76	114 069.27	117 905.96
IV. Staff loan fund	518 237.39	554 508.01	591 451.46	628 931.99
V. Building reserve fund	1 911 246.70	5 635 646.30	9 383 731.19	10 051 645.90
VII Medical insurance . reserve fund	1 789 192.08	1 918 336.70	1 966 053.11	2 113 650.36
Totals	<b>52 818 026.78</b>	<b>58 867 440.13</b>	<b>57 908 830.96</b>	<b>64 745 475.70</b>

Prof. Kovalevsky thanked Dr Kaarls for his report, which was approved by the Committee.

**3 NOMINATION OF THE NEXT DIRECTOR OF THE BIPM**

Dr Kaarls presented the report of the Search Committee, saying that sixteen applications had been received in response to the announcement, and that eight candidates had been invited for interview. A short list of three candidates had been drawn up for presentation to the CIPM, although just prior to the meeting one of them had written to withdraw his candidature. This therefore left the CIPM the choice between two candidates. After an extensive discussion a secret ballot was held and Dr Andrew J. Wallard, Deputy

Director at the NPL (United Kingdom) and member of the CIPM, was elected Director Designate.

## **4 MEMBERSHIP OF THE CIPM**

### **4.1 Elections and possible future candidates**

Prof. Kovalevsky reiterated that Dr Iizuka, Vice-President of the CIPM and member since February 1986, had announced his intention to retire from the CIPM at the end of June 2001. The CIPM then proceeded to its confidential discussion on possible future candidates.

### **4.2 Election of Honorary Members**

Prof. Kovalevsky proposed that Dr Bill Blevin, who resigned from the CIPM on 30 June 1999, should be elected Honorary Member. Dr Blevin had been a member of the CIPM for eighteen years and a member of its bureau for eight. The Committee agreed unanimously.

Dr Brown asked what were the rights and responsibilities of Honorary Members. Prof. Kovalevsky replied that there were no responsibilities but that Honorary Members were invited to participate in CIPM meetings, as is the case for Prof. Kind on the present occasion. Of course, Honorary Members do not vote.

## **5 THE MUTUAL RECOGNITION ARRANGEMENT**

Dr Quinn, Chairman of the JCRB, presented a brief report of the 5th meeting, which was held at the BIPM from 11 to 13 October 2000. The outcome of the JCRB meeting, and the consequences in general of the MRA, were examined at the meeting of directors of national metrology institutes, held at the BIPM

on 18 October 2000. The documents representing the outcome of the JCRB meeting are available on the BIPM website.

In the discussion on Dr Quinn's report, Dr Iizuka suggested that the sources of traceability of equipment used should be indicated explicitly for the evaluation of submitted calibration and measurement capabilities (CMCs). He said that, for APMP members in particular, the traceability of European results was not always transparent. Dr Quinn asked Dr Kaarls and Dr Wallard, also present at the JCRB meeting, to comment on the requirements. They both agreed that traceability was essential, but contended that it was clearly implicit in the requirements, and indeed always considered by the RMOs. Dr Kaarls reminded the Committee that the area of the BIPM key comparison database concerning traceability – the “blue” section – would be available to experts only, and not to the general public. Dr Iizuka argued that it was important to be absolutely open about the CMCs. Dr Kaarls promised to raise the question of what is required by users at the occasion of the next ILAC meeting.

Dr Inglis commented that the question of competence was equally important as that of traceability, and that the former issue was well covered by the peer-review process. The RMOs all have procedures already in place to address the various requirements of the JCRB and these seem to cover traceability adequately.

Prof. Kind recalled a question that had been raised at the meeting of directors the previous day: Which directors are included under the description “directors of national metrology institutes”? The directors of designated laboratories are also invited to attend the annual meeting of directors. Dr Quinn agreed that it should be made clear that the MRA is signed by the director of only one national metrology institute per country (see MRA) but that this signatory can designate other participating institutes (included in italics in the list of signatories). Prof. Kovalevsky noted that there was some contradiction between this and the EUROMET interpretation.

## 6 CONSULTATIVE COMMITTEES

### 6.1 Consultative Committee for Units

Prof. Mills, President of the Consultative Committee for Units (CCU), reported that, although no meeting had been held in the last year, he had been invited to report to the CIPM in the light of the 21st General Conference. He reminded the Committee that the CCU presented two draft resolutions at the CGPM in October 1999. The first was that the special name katal, symbol kat, should be adopted in the SI for the coherent derived unit mol/s, to express values of catalytic activity in the field of clinical medicine and biochemistry. This name and symbol have already been in use for some years, and its adoption as an official unit of the SI will encourage use of the SI and ensure safety in measurements concerning human health. This resolution was adopted as Resolution 12 of the CGPM, and the consequent changes to the SI brochure are available as a supplement to the 7th edition.

The second resolution was a proposal that the neper, symbol Np, be adopted in the SI as the coherent derived unit of logarithmic decay, and that the bel and decibel, symbols B and dB, be recognized as non-coherent units of this quantity. This proposal gave rise to some discussion and expressions of doubt at the CGPM, and in the event the bureau of the CIPM in consultation with the President of the CCU considered it best to withdraw the resolution, because changes to the SI should only be made when there is a strong consensus.

Prof. Mills explained that the quantity logarithmic decay, and the units neper, bel and decibel, may have been unfamiliar to many delegates at the CGPM, and this unfamiliarity may have been behind the doubts expressed. He said that he and two other members of the CCU (B.N. Taylor and A.J. Thor) were preparing a paper about the subject, with the aim of explaining more fully the significance of the quantity logarithmic decay and the units neper and bel. The paper will be submitted to *Metrologia* within the next few months, and the CCU will discuss the matter again at their meeting in 2001, with a view to presenting the recommendation again to the CIPM, and resubmitting the resolution to the CGPM in 2003.

Other matters to be discussed at the next CCU meeting include matters concerning the terminology and language associated with the SI, possible extensions of multiple and submultiple prefixes, the possible introduction of a

unit “uno = 1” for use with prefixes, to displace ppm and ppb, possible ways of redefining the kilogram, and the general responsibilities of the CCU and its members.

Prof. Kovalevsky thanked Prof. Mills for his report and invited discussion. Prof. Göbel and Dr Iizuka, Presidents of the CCEM and CCM, commented that it was far too early to discuss a new definition of the kilogram, but agreed that an exchange of views and a discussion of possible new definitions was appropriate. Dr Wallard agreed that links between the Consultative Committees should be encouraged and welcomed Prof. Mills’ suggestion to link the discussions of the CCU to the technical work of the CCM. Prof. Gopal and Dr Brown stressed the importance of any new definition being widely understandable, and Prof. Gopal noted that preparation of detailed instructions for the realization of the kilogram was a separate matter and that the *Mise en pratique* could be updated every few years. Dr Quinn agreed that the CIPM should advise the CCU to keep the definition simple.

## 6.2 Consultative Committee for Electricity and Magnetism

Prof. Göbel presented the report of the 22nd meeting of the Consultative Committee for Electricity and Magnetism (CCEM), held in September 2000 at the BIPM. He highlighted work being undertaken towards redefining the kilogram, and noted the recent CODATA adjustment of the fundamental constants. He presented a draft Recommendation based on the CCEM declaration concerning the uncertainty of the von Klitzing constant  $R_{K-90}$ . The CIPM agreed with the principle of the CCEM declaration but Dr Quinn observed that there remained a problem with the size of the uncertainty, and the Committee agreed that further discussion was necessary before the recommendation could be approved. Prof. Göbel had to leave the meeting before this discussion could be concluded. After the meeting it was agreed between Prof. Göbel and Dr Quinn that there was no need for a CIPM Recommendation; instead, the CIPM approval of the CCEM declaration was all that was required and this had been given.

Dr Wallard asked about activity in the field of magnetism. Prof. Göbel replied that a key comparison was approved, for which the PTB is acting as pilot laboratory.

### 6.3 Consultative Committee for Amount of Substance

Dr Kaarls presented his report of the 6th meeting of the Consultative Committee for Amount of Substance (CCQM), held at the BIPM on 6 and 7 April 2000. The CCQM approved the results of the key comparisons of gas mixtures, which have since been published in Appendix B of the MRA. These are the first key comparison results published in the BIPM key comparison database.

Much discussion took place on the calculation of the key comparison reference values. Special problems can arise in chemical measurements due to the inhomogeneity of complex samples. The CCQM agreed upon the format for entry of the CMCs in Appendix C of the MRA for chemical measurements and certified/primary/standard reference materials. CMCs for gas mixtures will be discussed by the JCRB in March 2001 and published by May 2001. With respect to classification of the different types of comparisons and reference materials and CMCs for Appendix C of the MRA, the CCQM plans to harmonize its classification system with those of the IUPAC, the ISO-REMCO and the COMAR database.

The five working groups of the CCQM reported on their activities. So far, in addition to sixteen key comparisons, thirty studies have been carried out or are under way, over a range of areas including health, food, the environment, advanced materials, commodities, forensics, and general analytical applications. Details of these studies are given in the full CCQM report of the meeting. All the working groups met during the period 29-30 November 1999, then participated in a CCQM workshop on uncertainty held at the BIPM on 1-2 December 1999. In the light of the success of this workshop it has been decided to hold a second CCQM symposium on primary methods, with emphasis on the question "How far does the light shine?" The proceedings of this symposium were published by the BIPM in the form of a CD.

Two *ad hoc* working groups have been established: one to study surface analysis, and another, chaired by experts from the LGC and the NIST, to focus on metrology in biotechnology. This latter was formed as a result of two presentations on the subject, highlighting DNA measurements in particular.

Prof. Mills asked if the CCQM had discussed the proposal to change the name of the Committee, adding that he would like the expression "amount of substance" to become better known and that he believed the present name of the CCQM should be kept. Prof. Gopal and Dr Brown said that they supported changing the name to Consultative Committee for Metrology in Chemistry. Dr Kaarls agreed that changing the name had been suggested in order to

indicate the broad field of activity of the Committee, but asked the CIPM not to take a strong position until the CCQM had fully considered the idea. Prof. Moscati remarked that the proposed new name could open the door to a flood of other CCs such as Metrology in Medicine and Metrology in Architecture!

Dr Iizuka said that the field was certainly changing rapidly, but asked if it was really appropriate that the CIPM dealt with issues such as characterization of surfaces and characterization of DNA. It is not possible for the CIPM to respond to all of society's needs. Prof. Göbel commented that the CIPM should play a role only when there was a call for traceability. Dr Kaarls replied that the CCQM feels it should respond to needs, and topics such as genetically modified foods and forensic analysis are important in today's society. In all of these areas the CIPM can play a unique role in organizing international traceability of measurement standards. He added that the European Union is establishing its own evaluation network of traceability laboratories independently of the CIPM. Dr Brown agreed that the failure of the CIPM and its Consultative Committees to deal with new areas would weaken the position of the Metre Convention. Dr Quinn concluded the discussion by saying that if there is a requirement for a stable measurement system on the long term, then there is no alternative but to base all measurements that need long-term stability on fundamental constants.

#### **6.4 Consultative Committee for Thermometry**

Prof. Ugur said that the report on the 20th meeting of the Consultative Committee for Thermometry (CCT), held at the BIPM from 12 to 14 April 2000, was not yet available, but presented a summary of the issues discussed.

He noted that five of the CCT's key comparisons had been established in 1996, long before the Guidelines for Key Comparisons were published on the BIPM website (in March 1999). He said that their organization had therefore not complied with all of the Guidelines, and asked whether their results would nevertheless be considered valid for entry in Appendix B of the MRA. Dr Quinn replied that the Guidelines should indeed be considered as guidelines rather than strict rules, but recommended that comparisons started before the Guidelines were published should follow their spirit as far as possible, the amount of flexibility being best judged by the President of each Consultative Committee.



Dr Ugur commented that the pilot laboratories of the key comparisons were asked henceforth to report to Dr Pavese of the IMGC, who had done a tremendous amount of work in setting up the comparisons. He said that Draft A reports for some of the comparisons were being circulated, and mentioned that in some cases disagreements had arisen between the participating laboratories. He hoped to resolve such problems by holding frequent workshop meetings. He remarked that there was no consensus on how to establish the uncertainty of fixed points and that a workshop would be organized on how to establish the uncertainty of the triple point of water.

He reported that the Joint CCT/CCPR working group on the determination of thermodynamic temperatures by radiation thermometry had been renamed CCT Working Group 5. Finally he presented Recommendation T 1 (2000) on the extension of the ITS-90 below 0.65 K, stressing that the proposed PLTS-2000 was a provisional scale that might have to be modified in a few years' time when further data were available. Dr Quinn noted that the proposal had been widely circulated by Dr Rusby, Chairman of CCT Working Group 4, and that it has the tacit approval of the low-temperature community. With a minor amendment to express the melting pressure equation in terms of quantities, the text was adopted unanimously by the CIPM as Recommendation 1 (CI-2000).

The CIPM counselled Dr Ugur to be patient if discussions in the Committee appeared to be reaching an impasse.

## **6.5 Consultative Committee for Length**

Although the Consultative Committee for Length (CCL) had not met since the last CIPM meeting, Dr Chung Myung Sai gave a report on the activities of the two working groups.

He reported that the CCL Working Group on Dimensional Metrology (WGDM) had been busy with a heavy schedule of key comparisons and activities related to Appendix C of the MRA. The WGDM held its 5th meeting in September 2000, jointly with the 3rd meeting of the RMO representatives on length. Comparison CCL-K1, gauge blocks by interferometry, material: steel and tungsten carbide, is the first key comparison to have been completed, and the WGDM reviewed its results and recommended that the CCL approve them for inclusion in Appendix B of the MRA. Five other key comparisons are under way or about to be started. Rules for reviewing CMCs in the field of length were drafted and fine-tuned. The consensus is that the RMOs should

submit for inclusion in Appendix C only those CMCs for which sufficient evidence is available. Dr Quinn commented that Dr J. Pekelski, Chairman of the WGDM, had done an excellent job in drawing up a list of dimensional metrology services to be included in Appendix C.

Dr Chung then turned attention to a new technology for measurement of optical frequencies. He said that femtosecond Ti:sapphire combs with stabilized repetition rates had first been reported in the spring of 1999. Using a novel photonic-band-gap fibre, the span of these combs has since been extended to cover the wavelength range from the blue through to the infrared. If the repetition rate is stabilized on traceable caesium clock standards, the combs have the potential to allow high-accuracy measurement of any stable wavelength within this span. He said that the BIPM and a number of other laboratories have begun work on the technique. Dr Quinn said that Dr Ma, visiting research fellow in the BIPM Length section, was playing an important role in importing the femtosecond technology from the JILA to the BIPM. He said that the equipment should be in operation in advance of the next meeting of the CCL.

The next meeting of the CCL Working Group for the *Mise en Pratique* (WGMP) will take place in December 2000. There are a number of items on the agenda, including a review of the results of various international comparisons of lasers, consideration of protocols for future comparisons, a review of the *Mise en Pratique* in the light of expected new measurements, and the impact of the new comb technology and development of related research at the BIPM.

## 6.6 Consultative Committee for Acoustics, Ultrasound and Vibration

Dr Wallard, acting President of the Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV), reported that the CCAUV has met once and that the programme of comparisons is progressing well. He presented a prospective list of members and observers, and the CIPM gave their approval. The complete list is reproduced in Section 6.13.

Prof. Kovalevsky thanked Dr Wallard for having led the CCAUV during its instigation and proposed that Dr Valdés take over as President. The Committee agreed.

## 6.7 Consultative Committee for Mass and Related Quantities

Dr Iizuka, President of the Consultative Committee for Mass and Related Quantities (CCM), reported that he and the chairmen of the CCM working groups had held a very successful meeting at the NPL. He distributed reports from the CCM Working Group on Hardness and the new CCM Working Group for Fluid Flow. He said that the structure of the latter group has been decided; the Working Group for Fluid Flow will consist of its Chairman (Dr Mattingly of the NIST), and a steering committee comprising the chairman of six sub-groups: Air Speed, High-Pressure Natural Gas Flow, Low-Pressure Air Flow, Water Flow, Hydrocarbon Liquid Flow, and Volume. The respective chairmen have been elected, and a questionnaire to identify the names of contact persons for the sub-groups and to establish the calibration and measurement capabilities of the participant national metrology institutes has been widely distributed; other interested parties are asked to contact the Chairman of the Working Group for Fluid Flow. The size of the group reflects the economic importance of the subject, but Dr Iizuka said that the Working Group status appeared satisfactory, adding that there was no pressure from the community to form a new Consultative Committee.

The Working Group on Hardness held its first meeting as a full working group of the CCM in September 2000. Representatives of the IMEKO, ISO and OIML were present and reported on their activities. Problems in defining hardness were discussed at length and it was decided to circulate a questionnaire to all national metrology institutes who currently standardize hardness. Members of the Working Group on Hardness from Germany, Italy, Japan, the Netherlands and the United States, will coordinate the development of the questionnaire and the evaluation of the data received. An international comparison of Rockwell hardness scales with a diamond cone indenter has been completed. This is a supplementary comparison approved by the CCM; the results will be submitted to the CCM for inclusion in Appendix B of the MRA; the Working Group on Hardness will decide at its next meeting how to calculate the reference values. A supplementary comparison of Vickers hardness scales and a future pilot study to compare systems used for the geometrical measurement of Rockwell diamond conical indenters are being planned. CMCs for hardness are still being collated.

Dr Iizuka distributed a report on the key comparison CCM.D-K1 on density standards. The framework of this comparison has been approved and the detailed protocol is to be completed by the end of October 2000. At present nine candidate national metrology institutes have been selected to participate.

Prof. Kovalevsky encouraged Dr Iizuka to include, if possible, two participants from each of the RMOs.

#### **6.8 Consultative Committee for Time and Frequency**

Prof. Leschiutta reported that, accompanied by Dr Arias of the BIPM Time section and Prof. Pâquet, he had attended a two-day meeting at Washington related to the BIPM/IGS Pilot Project. A report of this workshop and of a meeting of the CCTF Working Group on Two-Way Satellite Time and Frequency Transfer, held on 5 and 6 October 2000 at the BIPM, will be presented at the next meeting of the CCTF.

#### **6.9 Consultative Committee for Photometry and Radiometry**

Dr Wallard reported that two working groups of the Consultative Committee for Photometry and Radiometry (CCPR) have met since the last meeting of the CIPM. He said that the working groups have proved a very effective means of continuing work between meetings, and that the invitation of regional experts and mathematicians and statisticians to the meetings has proved beneficial. The CCPR Working Group on Key Comparisons in particular has achieved much useful work.

#### **6.10 Consultative Committee for Ionizing Radiation**

Prof. Moscati, President of the Consultative Committee for Ionizing Radiation (CCRI), summarized the activities of the various working groups of the CCRI Sections and listed the key comparisons under way.

#### **6.11 *Ad hoc* Working Group on Viscosity**

Dr Kaarls reported that the new *ad hoc* Working Group on Viscosity met for the first time in May 2000 and discussed the retrievability of absolute measurement data from the NIST. The NRLM is developing a new primary method for viscosity. The date of the next meeting is not yet fixed (it has been postponed from November 2000).

### 6.12 Working Group on Gravimetry

Prof. Kovalevsky said that he had received a letter from Dr M. Vermeer, President of the International Gravity and Geoid Commission of the International Association of Geodesy supporting a proposal of the IAG/IUGG Working Group 6 on International Comparison of Absolute Gravimeters for the creation of a formal working group under the auspices of the CIPM. Dr Vitushkin, Chairman of the group, is currently organizing the 6th International Comparison of Absolute Gravimeters (ICAG 2002), which will be held at the BIPM during 2002. Dr Vermeer said that the value of  $g$  is of interest in a wide range of applications, and requested that the results of the gravimetry comparisons be recognized in the database linked to the MRA. To this end, he asked that the Working Group be granted formal status within the framework of the Metre Convention.

The CIPM approved this proposal in principal, but was not in favour of extending the remit of the new group to cover seismometry. The CIPM then considered to what body such a working group should best be attached. It was agreed that it would be best for the working group to operate under a Consultative Committee, because attachment to the CIPM directly would imply that the chairman of the working group must be a member of the CIPM. Since the CCM, which is the obvious choice, already has nine working groups, it was agreed that a new Working Group on Gravimetry should operate under a Consultative Committee, perhaps the CCAUV but that the CIPM bureau will formalize this arrangement during the course of the year; the list of members will be presented at the next meeting of the CIPM (October 2001).

### 6.13 Membership of Consultative Committees

A large number of applications for membership of Consultative Committees were discussed.

The list of members and observers of the CCAUV was formally approved as follows:

*Members:*

Bureau National de Métrologie, Institut National de Métrologie [BNM-INM],  
Paris

Centro Nacional de Metrología [CENAM], Querétaro

CSIR, National Metrology Laboratory [CSIR-NML], Pretoria  
D.I. Mendeleyev for Metrology, Gosstandart of Russia [VNIIM],  
St Petersburg  
Danish Institute of Fundamental Metrology [DFM]/Danish Primary  
Laboratory for Acoustics [DPLA], Lyngby  
Istituto di Metrologia Gustavo Colonnelli, CNR [IMGC], Turin  
Istituto Elettrotecnico Nazionale Galileo Ferraris [IEN], Turin  
Korea Research Institute of Standards and Science [KRISS], Taejeon  
National Institute of Metrology [NIM], Beijing  
National Institute of Standards and Technology [NIST], Gaithersburg  
National Measurement Laboratory, CSIRO [CSIRO-NML], Lindfield  
National Physical Laboratory [NPL], Teddington  
National Physical Laboratory of India [NPLI], New Delhi  
National Research Council of Canada [NRC], Ottawa  
National Research Laboratory of Metrology [NRLM], Tsukuba  
NMI Van Swinderen Laboratorium, Nederlands Meetinstituut [NMI-VSL],  
AR Delft  
Office Fédéral de Métrologie et d'Accréditation/Swiss Federal Office of  
Metrology [Metas], Bern-Wabern  
Physikalisch-Technische Bundesanstalt [PTB], Braunschweig

*Observers:*

All Russian Scientific and Research Institute for Metrology for Physical-  
Technical and Radiotechnical Measurements, Gosstandart of Russia  
[VNIIFTRI], Moscow  
Bundesamt für Eich- und Vermessungswesen [BEV], Vienna  
Central Office of Measures/Główny Urząd Miary [GUM], Warszawa  
Czech Metrology Institute [CMI], Praha  
Instituto Português da Qualidade [IPQ]/Laboratório Nacional de Engenharia  
Civil [LNEC], Caparica  
International Electrotechnical Commission [IEC], Geneva  
International Organization for Standardization [ISO], Geneva  
National Centre of Metrology [NCM], Sofia

National Metrology Institute of Turkey/Ulusal Metroloji Enstitüsü [UME],  
Gebze-Kocaeli  
Singapore Productivity and Standards Board [PSB], Singapore  
Slovak Institute of Metrology/Slovenský Metrologický Ústav [SMU],  
Bratislava

In addition the following were approved:

Committee	New members	New observers
CCEM	PSB (Singapore)	INTI (Argentina) UME (Turkey)
CCL	MIKES (Finland) UME (Turkey)	PSB (Singapore)
CCM		CSIR (South Africa) NPL (India) UME (Turkey)
CCQM		CENAM (Mexico) PSB (Singapore) UME (Turkey)
CCPR	NMi-VSL (The Netherlands)	PSB (Singapore)
CCRI Section I		CSIR (South Africa)
CCT	CSIR (South Africa) UME (Turkey)	INTI (Argentina)
CCTF		CSIR (South Africa) PSB (Singapore) UME (Turkey)
CCU	CEM (Spain)	

It was agreed that the applications of the PSB (Singapore) for membership of the CCM and the CSIR (South Africa) for full membership of the CCL would be reviewed next year.

Dr Wallard suggested that a list of criteria be drawn up, in parallel to that on membership available on the BIPM website, to describe observer status, and the possible transfer from observer to full member. Dr Quinn agreed to circulate a draft list in advance of the next meeting of the CIPM and reminded the Presidents of the Consultative Committees that they retained the power to change the status of a member to that of observer. He recommended that the Presidents of the Consultative Committees take this opportunity to review their membership lists. Dr Kaarls noted that although national metrology institutes planning activity in a field are not admitted as observers, the President of a Consultative Committee can invite them to attend on an *ad hoc* basis.

#### 6.14 Future meetings

The following dates were agreed:

CCAUV	4-5 October 2001
CCL	19-20 September 2001
CCM	May 2002
CCPR	24-26 April 2001
CCQM	4-6 April 2001
CCRI	29 May 2001(afternoon)
Section II	21-23 May (morning) 2001
Section I	23 May (afternoon) - 25 May 2001
Section III	28-29 May (lunch time) 2001
CCT	12-14 September 2001
CCTF	20-21 June 2001
(preceded by meeting of TAI laboratories)	19 June 2001
CCU	19-20 April 2001
CIPM	10-12 October 2001
JCRB	8 March 2001 (at the NIST, United States)
	8-9 October 2001 (at the BIPM)
BIPM/OIML/ILAC	21 February 2001 (at the BIML)



**7 METRE CONVENTION/OIML JOINT WORKING GROUP**

Continuing the issues raised by Dr Kaarls under item 2.7, Dr Quinn thanked Dr Brown for her positive reaction to the suggestion that the NIST host the second symposium on the role of metrology in economic and social development, organized jointly with the BIPM, the IMEKO and OIML. Dr Brown confirmed that this meeting would be held at the NIST towards the end of 2001, probably in November.

Concerning the draft law on metrology, Dr Quinn explained that this had been created by the OIML to serve as a basis for adoption as a national law, primarily by developing countries. The text had been drawn up nearly forty years ago, as one of the very first actions of the OIML, and the OIML now wished to revise and generalize it. Such a project will clearly involve the BIPM and ILAC and Dr Charles Ehrlich of the NIST is heading a working group on the subject, which will form part of the agenda of the next joint meeting of the BIPM, ILAC and OIML, to be held in February 2001.

Dr Quinn then commented on the Joint Committee for Guides in Metrology (JCGM), of which he is Chairman. The JCGM operates through two working groups, both of which are due to meet at the BIPM in November 2000. Working Group 1, on the *Guide to the Expression of Uncertainty in Measurement* (the GUM), is chaired by Dr Barry Taylor of the NIST and is making good progress. Working Group 2, on the other hand, on the *International Vocabulary of Basic and General Terms in Metrology* (the VIM), is currently chaired jointly by Dr Quinn and Prof. Giacomo and is making little progress. Dr Quinn said that it seemed to be impossible to achieve a consensus for improvement, and that he was tempted to abandon the project if the forthcoming meeting was no more successful. Dr Wallard suggested that it might be useful for the JCGM to invite statisticians to its meetings.

Dr Kaarls remarked that he was keen to see modifications taking account of the field of chemistry. Prof. Issaev suggested that account also be taken of the OIML documentation on vocabulary for legal metrology, and Dr Quinn replied that the OIML's views were indeed taken into account as they were a participating member of both the working groups.

Prof. Gopal asked whether there had been any developments concerning the housing of the ILAC secretariat at the BIPM. Dr Quinn replied that the ILAC

were still holding internal discussions on the possibility and that no decision had been made as yet.

Prof. Moscati asked Dr Kaarls, who represents the BIPM at the ILAC General Assembly, to comment on ILAC's position regarding calibration and accreditation. Dr Kaarls replied that the accreditation community had been one of the driving forces behind the MRA, and that ILAC was currently drawing up its own mutual recognition arrangement. He highlighted the importance of these two Arrangements being linked and coherent, and said that the matter would be discussed further at the ILAC meeting to be held in Washington in November 2000. At the same occasion he would ask if ILAC has any other needs that should be addressed by Appendix C of the MRA. He then described a proposal by the EC that accreditation services, including the accreditation of calibration laboratories which together with the national metrology institute constitute the national metrological infrastructure in a country should be separated from the national metrology institutes.

The CIPM at its meeting of 20 October 2000 approved the following statement:

- the national calibration service is a part of the national metrology infrastructure in which the national metrology institute has a vital interest and specific responsibilities;
- the calibration laboratories are part of the national calibration service and in general are accredited in accordance with the relevant laboratory accreditation criteria (ISO/IEC 17025);
- in many countries the accreditation body for calibration laboratories is a part of the country's national metrology institute;
- national metrology institutes in general only offer services that accredited laboratories do not or cannot deliver, in particular services that deliver traceability at the highest levels of accuracy in a country;
- calibration services at the highest level in general do not compete with the commercial activities of the accredited laboratories and thus no conflict of interest exists;
- calibration activities are not the same as conformity assessment activities;
- it should be left to the governments of the individual countries to decide how they wish to organize their metrology infrastructure, including the accreditation of their calibration laboratories; the delivery of accreditation should not, of course, compromise the fundamental criterion of impartiality;

- in those countries where the National Accreditation Body for Calibration Laboratories is part of the national metrology institute, sufficient measures have normally been taken to ensure impartiality.

The CIPM welcomes a discussion on the issues mentioned above in the regular meetings of ILAC, OIML and the BIPM/CIPM, the next meeting being held on 21 February 2001.

## **8 WORK OF THE BIPM**

### **8.1 Director's Report and presentation of the scientific work by the staff of the BIPM**

The Director introduced his report in the following terms \*:

There are two innovations in the presentation of the Director's Report this year. The first concerns the text of the Report. In the past, the text of the Director's Report dated 1 July and distributed to members of the CIPM was considered a draft which was updated in October after the meeting of the CIPM. This will no longer be the case. Starting this year the 1 July version of the Report is the definitive one and is intended to be an account of the work carried out since 1 October 1999 and under way in the laboratories of the BIPM on 1 July 2000. The second innovation is that in this year's Report no results of international comparisons are given. Instead, the occurrence of each comparison is noted and reference is made to appropriate publications (BIPM reports or outside publications) where full details and results will be found. Results appear in the BIPM key comparison database as soon as they are approved. This is to make it clear that henceforth the official results of BIPM comparisons are those that are listed on the BIPM key comparison database.

I have also made an attempt to shorten the text. All of the significant scientific work carried out at the BIPM is published in the open literature, either in

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\* For the first time, the full text of the *Director's Report on the Activity and Management of the Bureau International des Poids et Mesures* is published separately and here I give only a brief summary and notes on the discussion by members of the CIPM that followed the presentation.

refereed publications or in conference proceedings. The aim of this report is to give a brief summary of the work with a complete list of references to publications where full information will be found. In addition to references to published articles, I include references to articles that have been submitted and accepted for publication but have not yet appeared in print. For these, preprints are available on request from the authors and the full reference will appear in next year's report. No reference is made to articles submitted but not yet accepted.

The report includes a relatively detailed description of the BIPM key comparison database. It describes the work that went into its successful launch on the BIPM web page on 30 November 1999 and the recent inclusion of the first results of key comparisons to have passed through the complete process specified in the MRA. We at the BIPM are very conscious of the huge amount of work that is now going on in the national metrology institutes concerning the key comparisons and, more particularly, the preparation of the calibration and measurement capabilities destined for Appendix C of the MRA. We are doing all that we can to ensure that the BIPM side of the operation is carried out as efficiently as possible and that maximum support is provided to our colleagues in national metrology institutes. With regard to the development of the BIPM key comparison database, the considerable progress that has been achieved would not have been possible without the close cooperation that has existed between the BIPM and the NIST, a collaboration which is gratefully acknowledged.

On 10 November 1999, Dr Elisa Felicitas Arias took up the post of Head of the Time section and on 1 May 2000, Dr Robert Wielgosz took up the new post of Head of the Chemistry section. Other appointments, departures and promotions are listed in their usual place at the end of this report.

The following is a summary of the scientific work of each section.

**Length:** International comparisons mainly concerned lasers working at the recommended wavelength of  $\lambda \approx 633$  nm. The BIPM lasers at  $\lambda \approx 633$  nm took part in comparisons with lasers of the following national laboratories: NIST-JILA, NRC, PTB, VNIIFTRI and VNIIM. A first comparison involving the BNM-INM (France), IMGC (Italy) and PTB (Germany) was carried out at the BIPM for doubled Nd:YAG lasers operating at the recommended wavelength of  $\lambda \approx 532$  nm. Recently considerable improvements have been obtained on both of the BIPM lasers for their frequency stability. Relative Allan standard deviations have now reached the level of  $5 \times 10^{-15}$  for a 500 s sampling time. This is close to the best value that has been obtained at the JILA.

Significant progress was made in the construction of BIPM He-Ne laser tubes for the wavelength  $\lambda \approx 3.39 \mu\text{m}$ . Our collaboration with the Institute of Laser Physics (St Petersburg) for the realization of a cheap and easy-to-use Nd:YAG laser for length measurements seems promising, with several national laboratories already showing some interest.

**Mass:** A new 1-kg balance destined for calibration work has been fully instrumented and intensively studied. We believe the reproducibility of this device can still be improved and work continues to that end. Our programme to minimize problems associated with corrections of air buoyancy is well advanced with the ability now to monitor changes in air density using a novel refractometer. This method complements the traditional reliance on an equation-of-state whose inputs are temperature, pressure, dew-point temperature and carbon-dioxide content. A third method, that measuring the difference in mass of specially made buoyancy artefacts will be added shortly. Measurements of the Newtonian gravitational constant,  $G$ , continue. We have achieved very satisfactory precision using our most recent apparatus but must still resolve the problem of an accurate calibration of our electrostatic servo-control transducer.

**Time:** In the Time section, the medium-term stability of International Atomic Time TAI, expressed in terms of an Allan deviation, is estimated to be about  $0.6 \times 10^{-15}$  for averaging times of twenty to forty days. The accuracy of TAI is based on six primary frequency standards: the three classical standards CS1, CS2 and CS3 from the PTB, operating continuously, and three optically pumped standards CRL-01, NIST-7 and NRLM-4. As a consequence of better stability and increase in the number of primary standards, the scale unit of TAI has been estimated to match the SI second to within  $4 \times 10^{-15}$  since October 1999. An important part of the activity deals with studies of time and frequency comparison using navigation satellite systems such as GPS and GLONASS, with a particular emphasis on multi-channel multi-system techniques, and on the use of GPS carrier-phase measurements. Besides the classical GPS common-view technique based on C/A-code measurements obtained from one-channel receivers, three GPS multi-channel links and four two-way time transfer links are used in the calculation of TAI. Research work is also dedicated to space-time reference systems, particularly to the relativistic framework for defining and realizing coordinate times. The BIPM Time section submitted a proposal to participate jointly with the USNO in the International Earth Rotation Service in the establishment of conventions for

the space-time reference systems. Other research subjects are pulsars, future clocks in space and atom interferometry.

**Electricity:** The calibration work in the Electricity section this year reflects the keen interest in capacitance measurements in the national metrology institutes; a total of fourteen standard capacitors from five national metrology institutes were calibrated. These calibration results are expressed in terms of our realization of  $R_{K-90}$  with a relative standard uncertainty of 5 parts in  $10^8$ . The work in the area of comparisons of voltage standards remains steady with three new bilateral comparisons and the fourth and final round of BIPM participation in the EUROMET 10 V comparison. We have achieved a significant breakthrough in the ac measurement of the QHR at kHz frequencies this year: the linear frequency dependence of the QHR has been reduced from a few parts in  $10^7$  per kHz to  $\pm 2$  parts in  $10^8$  per kHz. This work establishes a method for using the QHE as an independent quantum impedance standard. Once again Dr B.P. Kibble, who spent two months with us this year as a guest worker, was a valuable participant in this effort. Our studies of  $1/f$  noise in Zener-diode voltage standards included a survey of fifteen different instruments. All have  $1/f$  noise that limits the Allan deviation of the 10 V outputs to a value characteristic of each instrument but which remains in the range between 20 nV and 80 nV, even if a great number of measurements are made. This is a fundamental limitation of this type of voltage standard. We also used spectral analysis and Allan variance techniques to characterize the noise and stability of a number of nanovoltmeters. In an ordinary laboratory environment, the Allan variance is usually limited by variations of the ambient temperature. In constant temperature conditions the ultimate limit is  $1/f$  noise. The results can be used to evaluate the performance of instruments and to optimize the design of measurement routines.

**Radiometry, photometry:** Work has begun on the realization of a standard of near-infrared spectral irradiance using the high-temperature sodium heatpipe black body. Characterization of the black body is currently under way and its temperature stabilization was developed. The first successful radiometric measurements of temperature were made with three calibrated filter radiometers to verify the principle. The detectors for the CCPR key comparison of spectral responsivity in the visible range have been mounted, characterized and calibrated. They will be sent to the first group of participants later this year. Following completion of the supplementary comparison CCPR-S3 of cryogenic radiometers, one participant asked for a bilateral comparison with the BIPM. This exercise is now in progress. A check

of aperture-area measurement capabilities at the BIPM and the PTB was conducted. Bilateral lamp comparisons of luminous flux and luminous intensity were also made with the PTB.

**Ionizing Radiation:** The significant programme of equipment renewal and laboratory upgrading has continued, including the installation of the new air conditioning systems. Consequently, in the field of photon dosimetry, only one BIPM comparison has been undertaken in the last seven months although eight are planned before the end of 2000. However, eight national metrology institutes are participating in a CCRI dosimetry comparison which is being run by the section. In addition, sixteen calibrations have been made for secondary standards laboratories. The Monte-Carlo calculations for electron loss and photon scatter correction factors for free-air chambers are proving to be very useful to national metrology institutes, with closer agreement in comparison results being achieved. An additional  $^{60}\text{Co}$  source has been ordered with the new irradiation head required to obtain transport approval from the French authorities, and should be installed by the end of 2000. In the radionuclide field, a working group is undertaking actions to improve future comparisons of radionuclides with emissions similar to those from  $^{204}\text{Tl}$  as the results of the comparison with this nuclide were not acceptable. The trial comparison of activity measurements of  $^{152}\text{Eu}$  has been extended to a full comparison involving twenty-four national metrology institutes and the final results are awaited. A new comparison of  $^{89}\text{Sr}$  activity has begun with the issue of radioactive solutions to twenty-two participants and a comparison of  $^{238}\text{Pu}$  is planned for the autumn. There was a 9 % increase in submissions to the International Reference System (SIR) this year and the monograph which will incorporate the comparison procedure as well as all past results should be ready before the end of the year. This will enable the degrees of equivalence of national standards to be submitted to the BIPM key comparison database. The BIPM gamma-ray spectrometer is proving very useful in the determination of contaminants in submitted samples and its upgrade to a hyperpure Ge-based system is well under way. Other studies in absolute activity methods are continuing.

**The BIPM key comparison database:** The BIPM key comparison database was officially opened to the public via the internet on the BIPM website on 30 November 1999. The database includes information on some three hundred and fifty key and supplementary comparisons now being carried by national metrology institutes and the results of those completed as they become available. By December 2000, the database will include an increasing amount

of data concerning the calibration and measurement capabilities of the national metrology institutes that are signatories of the MRA. The data put on the BIPM key comparison database passes through many stages of verification and checking to ensure that it is reliable. Most of this is done by the national metrology institutes working through the regional metrology organizations. The JCRB takes an important role in coordinating all the activity related to the data entering the database concerning calibration and measurement capabilities of the national institutes.

**Chemistry:** Following a decision of the CIPM, already mentioned at the 21st General Conference in October 1999, a Chemistry section is being established at the BIPM. The programme of work will initially focus on certain aspects of gas metrology, in particular the establishment at the BIPM of standards for atmospheric ozone. The laboratories for this work are being established in part of the building used for ionizing radiation standards and are expected to be ready for occupation in the spring of 2001.

The scientific staff of the BIPM presented their work to the CIPM. In addition to presentations of the work in the laboratories, Dr Thomas gave a brief talk about the BIPM key comparison database which had been opened on the BIPM website since the last meeting of the CIPM and Dr Wielgosz, Head of the new Chemistry section, presented the proposed programme of work in metrology in chemistry at the BIPM (see Section 8.2).

Following the presentations, Dr Kaarls asked about the implications of the new comb generator technology. Dr Quinn replied that rapid progress is being made in this field and the technique has enormous potential. As it will enable direct measurement of optical wavelengths, it is clearly of great interest to the BIPM and work is under way to set up the appropriate apparatus in the BIPM Length section. To this end, Dr Ma of JILA spent six months this year as a visiting worker at the BIPM and will return for another period in 2001.

Dr Valdés commended Dr Witt's study of time series in electrical measurements, and Dr Quinn remarked that Dr Witt's findings were important in all fields of metrology. He recommended that the results of the study be borne in mind whenever an experiment is designed.

Prof. Issaev posed a general question concerning the base units of the SI, suggesting that the lumen would be a more appropriate base unit than the candela. Dr Köhler replied that he agreed in principle but noted that the candela was defined when the basic reference was a standard source and at



that time luminous intensity was the natural quantity to be taken to define the unit.

The President thanked the Director and staff for their excellent presentations, and expressed his particular best wishes to the new Chemistry section.

## **8.2 Installation of the new BIPM Chemistry section**

Dr Wielgosz said that the programme of scientific work for the new Chemistry section of the BIPM has been drawn up with the assistance of a panel of experts from the CCQM Working Group on Gas Analysis. The programme foresees the chemistry laboratories at the BIPM specializing in gas metrology, and in particular ozone measurements. During the initial five-year period of the programme, the primary aim will be for the BIPM to establish itself as the pilot laboratory for international ozone measurement comparisons and calibrations, facilitating an international SI-traceable infrastructure for these measurements via the CIPM key comparison programme. Two additional programmes will relate to primary gas standards and high-accuracy methods for comparisons of gas standards.

The chemistry laboratories are currently being constructed on the ground floor of the Ionizing Radiation building. This work is due for completion by April 2001, and three members of staff will be recruited during the year.

## **8.3 Tour of the new building**

Accompanied by Mrs Perent (Administrator of the BIPM), Mr Sanjaime (Head of the BIPM workshop), Mr Richer (Préfet des Hauts-de-Seine), and Mr Gatier (architect), the CIPM visited the site of the Pavillon de Mail, where construction work is progressing according to schedule. Dr Quinn said that future meetings of the CIPM will continue to be held in the traditional Grande Salle, but as from next year the staff presentations will be given in the conference room in the new building. Consultative Committees will also meet in the new facilities, due for completion in May 2001.

#### 8.4 Depository of the metric prototypes

On 18 October 2000, at 17 h 30, in the presence of the President of the Comité International des Poids et Mesures (CIPM), the Director of the Bureau International des Poids et Mesures (BIPM) and the representative of the Curator of the Archives Nationales de France, the visit to the depository of the metric prototypes at the Pavillon de Breteuil took place.

The three keys necessary to open the depository had been assembled: the key entrusted to the care of the Director of the Bureau International, the one deposited at the Archives Nationales in Paris which Mrs Arnault, Director of the Archives Nationales, had brought, and finally the one kept by the President of the Comité International.

The doors of the vault having been opened as well as the safe, we observed the presence in the safe of the international prototype of the kilogram and its official copies.

The following indications on the measuring instruments placed in the safe were noted:

temperature:	22 °C
maximum temperature:	24 °C
minimum temperature:	22 °C
relative humidity:	54 %

We then locked the safe as well as the doors of the vault.

The Director	For the Curator	The President
of the BIPM	of the Archives de France	of the CIPM
T.J. Quinn	Mrs M.P. Arnault	J. Kovalevsky

## 9 ADMINISTRATIVE AND FINANCIAL AFFAIRS

### 9.1 Administrative and financial affairs

The CIPM invited Mrs Perent, administrator of the BIPM, to be present for these items of the agenda. The *Rapport annuel aux Gouvernements des*

*hautes parties contractantes sur la situation administrative et financière du Bureau International des Poids et Mesures en 1999* was approved without discussion.

Dr Quinn then presented the current financial situation for 2000 and a draft budget for 2001. The budget for 2001 was expressed in euros for the first time, the total budget being approximately 9 million euros. After a short discussion the CIPM approved the proposed budget for 2001.

Dr Quinn then turned attention to the investment policy of the BIPM pension fund. He reminded the Committee that they had, since the 10th CGPM in 1954, full authority over the fund, which was set up by the Member States in 1901. The pension fund is thus the responsibility of the CIPM and the CIPM is responsible for paying the pensions of the staff. The pension rights of the staff are laid out in the Rules for the pension fund and are independent of the resources of the pension fund (a full account of the financial structure of the pension fund is given in the Report of the 1994 meeting of the CIPM). Dr Quinn proposed that a more advantageous way of increasing in the long term the assets of the fund would be to invest a modest fraction of the investments in long-term placements in the stock market, rather than investing the entirety in government bonds as has been the practice up to now. He proposed that 20 % of the present pension fund be invested in this way and said that such a step would be in line with general policy in private pension funds. It is accepted that in the long term investments in the stock market provide a better return than secure bonds. The risk is that in the short term, significant fluctuations occur. Dr Quinn reassured the Committee that the choice of investments would rest with the BIPM and these would be widely spread and would be based on the advice of our bank, the Crédit Commercial de France (CCF). He said that this change in investment policy concerning the pension fund would be discussed with the staff but they would be assured that their pensions remain secure. The CIPM approved the proposal.

The CIPM also agreed that the actuarial study of the pension fund, foreseen in 1994 to take place in 1999 should be postponed but that it be carried out before the 22nd CGPM in 2003.

## **9.2 Staff Statutes**

Dr Quinn then proposed a modification to the staff statutes to improve the situation of members of staff leaving the BIPM without having completed the seven years of service required to qualify for a pension. He said that this was

of particular importance for young research fellows who stay for a short time and for the occasional member of staff that joined the BIPM after the age of fifty-eight and who reached the retirement age of sixty-five before having accomplished seven years of service. The CIPM unanimously approved his suggestion to align the BIPM practice with that of the Coordinated International Organizations. The refund will henceforth be equal to the total amount put into the pension fund on behalf of the person leaving, namely, the amount contributed by the staff member, which is 9 % of salary, plus twice this amount representing the contribution of the BIPM. The refund in total will thus be three times the personal contributions of the staff member. At present the refund is simply the staff member's contribution.

He also proposed, and this was agreed by the CIPM, to include in the statutes the formal possibility of inward and outward transfer of pension rights for those members of staff joining or leaving the BIPM after more than seven years service. The rules under which this can take place will be those of the Coordinated International Organizations.

The CIPM also approved his proposals to increase the level of family allowance in line with those of the Coordinated International Organizations.

He asked the CIPM to approve three other changes to the Staff Statutes: the change from gold francs to euros in the text of the Statutes, the extension to 13 of the grades accessible to the Administrateur and the introduction of a new category of staff into the statute: that of Chimiste. These were approved.

### 9.3 Promotions

The CIPM approved the promotion to *Physicien principal* of Mr Jacques Azoubib and Dr Włodzimierz Lewandowski, both of the Time section, and confirmed the appointment of Dr Robert Wielgosz, Head of the Chemistry section, at the grade of *Chimiste principal*. These decisions will take effect from 1 January 2001.

**10 NEW STUDY OF FUTURE NEEDS FOR METROLOGY**

Dr Kaarls presented a brief report on future needs for metrology. He remarked that in 1995, when the 20th CGPM requested that the CIPM study and report on the long-term national and international needs relating to metrology, members of the CIPM immediately suggested that the study should also consider the consequences of new scientific and technological developments and the application of advanced information technology on the activities and working methods of the national metrology institutes and the BIPM. At that time the CIPM decided to leave such elements out of the study in order to minimize delay, and to focus more on overall policy rather than technical issues. The issues are, however, of importance, especially because a timely study of future developments is of crucial importance to the BIPM and may help when considering priorities, choosing which activities to carry out, investing in new technologies, and recruiting staff.

Among the consequences of technical developments he cited the following examples:

- the wide application of intrinsically calibrated standards diminishing the number of calibrations carried out by the national metrology institutes and the BIPM;
- as a consequence, the rapidly increasing number of comparisons, including industries and other institutions;
- the future application of digital and information technology, leading to:
  - remote observed calibrations and comparisons,
  - remote controlled calibrations and comparisons,
  - remote and on-line data acquisition,
  - transmission of reference signals.

He reminded the Committee that the application of complex technologies often requires increased harmonization and description of methods and systems (particularly seen in the field of chemistry) and emphasized that new fields such as chemistry, biotechnology, food and the environment are considered important by the public, and that accurate and traceable measurements in these new fields must be available.

Dr Iizuka and Dr VanKoughnett expressed their strong support for the proposal that the CIPM take on an ongoing project to review future needs in

metrology. Dr VanKoughnett said he considered it important for the CIPM to spend more time on future planning and Dr Wallard agreed that a future programme that clearly demonstrated the strategic role of the BIPM could only advance in the case for the budget at the next CGPM.

Prof. Kovalevsky commented that a new document on future and long-term needs in metrology should be written in such a way that it is applicable not only to the BIPM but to all national metrology institutes. Dr Inglis added that the BIPM's role in supporting developing economies (non Member States) should also be considered.

Dr Kaarls noted that increased international cooperation and coordination may be beneficial, because initial investment costs can be very high, and that several directors of national metrology institutes have suggested that the BIPM take an active lead in coordinating such ventures. Prof. Issaev recommended that proposals for future work be sought not only from the national metrology institutes and the CCs but also through collaboration with the OIML, who he suggested should be invited to participate in the study.

Dr Valdés expressed his view that the CIPM should recommend national metrology institutes to develop a wide research base in nanometrology, not restricted to dimensional metrology. He highlighted recent progress in assembling nanostructures and nanoelectronic components, citing new developments that might find application in electrical metrology. He said that nanometrology should be considered not only from the point of view of miniaturization, but from the perspective of building up on the atomic scale. He forecast the construction of reference materials atom by atom or molecule by molecule as an application of nanochemistry to chemical metrology, saying that this would also permit the development of miniature thermal fixed point cells with absolutely pure substances. He concluded by saying that approaching the quantum limit might uncover new physical effects, not necessarily on the nanoscale, giving rise to the development of new measurement standards.

Prof. Kovalevsky thanked the Committee for their comments and said that the bureau would consider how best to tackle the project, which was not a simple task and should perhaps be divided among several members. The CIPM expressed their unanimous support and willingness to participate in the study.

**11 OTHER BUSINESS**

Prof. Moscati raised to the issue of dual nationality. He told the Committee that, although he was a Brazilian citizen, he was born in Italy and lost his Italian nationality when he became Brazilian. Since the laws regarding nationality have now changed, he now wished to take up his Italian nationality again. The Committee agreed that, if he decided to do this, the CIPM would still consider him as a Brazilian member.

Prof. Leschiutta and Dr Quinn reported that a very successful summer school had been held this year at Varenna, organized by Prof. Leschiutta and Dr Tavella, supported by the Italian Physical Society and promoted by the Istituto Elettrotecnico Nazionale Galileo Ferraris. He said that it had been attended by about eighty students, who had enjoyed high-quality lectures given by the invited speakers. The proceedings of the school will be printed in November 2000. Prof. Issaev said that a similar event had been held with great success by the Commonwealth of Independent States from the former USSR. Dr Quinn suggested that a regular summer school on metrology should be instigated for young physicists from the national metrology institutes, under the auspices of the CIPM. Prof. Gopal suggested that this be discussed with the directors of the national metrology institutes and Dr Iizuka agreed that it would be appropriate for such an event to be organized by individual national metrology institutes rather than the BIPM.

In response to a request from Dr Iizuka, Prof. Kovalevsky distributed a list of subscribers to *Metrologia*.

**12 DATE OF NEXT MEETING OF THE CIPM**

Prof. Kovalevsky closed the 89th meeting of the CIPM by thanking all participants for having contributed to an important and positive meeting. In particular he thanked Dr Iizuka for all the work he has done for the CIPM, both as a member and as Vice-President. Dr Quinn added that it had been a pleasure to work with him and expressed his appreciation for Dr Iizuka's

interaction with the BIPM Mass section, in particular concerning the acquisition of a new diamond-turning lathe and hardness-testing machine.

Dr Iizuka replied that he would be continuing in his active role until June 2001, at which time he will have been a member of the CIPM for fifteen years. He thanked Prof. Kovalevsky and Dr Quinn for their kind words and said that he was very pleased to have worked with the Committee.

The 90th meeting of the CIPM will be held on 10, 11 and 12 October 2001, immediately after the 7th meeting of the JCRB which takes place on 8 and 9 October.



**RECOMMENDATION ADOPTED BY THE  
COMITÉ INTERNATIONAL DES POIDS ET MESURES  
AT ITS 89TH MEETING**

**Recommendation 1 (CI-2000):**

**Extension of the International Temperature Scale below 0.65 K**

The Comité International des Poids et Mesures,

**considering**

- Resolution 9 of the 21st Conférence Générale des Poids et Mesures inviting the Comité International des Poids et Mesures to prepare a  $^3\text{He}$  melting pressure equation as a function of thermodynamic temperature to serve as the basis for an extension of the International Temperature Scale of 1990 (ITS-90) below its present lower limit of 0.65 K,
- that agreement has now been reached on a Provisional Low Temperature Scale, 0.9 mK to 1 K, PLTS-2000,

**recommends** that the PLTS-2000 be adopted on a provisional basis.

## Appendix to Recommendation C 1 (2000)

### The Provisional Low Temperature Scale from 0.9 mK to 1 K, PLTS-2000

#### 1 The scale

The scale is defined by the following equation relating the melting pressure  $p$  of  $^3\text{He}$  to temperature  $T_{2000}$ :

$$p / \text{MPa} = \sum_{i=-3}^{+9} a_i (T_{2000} / \text{K})^i$$

$$a_{-3} = -1.385\,544\,2 \cdot 10^{-12}$$

$$a_{-2} = 4.555\,702\,6 \cdot 10^{-9}$$

$$a_{-1} = -6.443\,086\,9 \cdot 10^{-6}$$

$$a_0 = 3.446\,743\,4 \cdot 10^0$$

$$a_1 = -4.417\,643\,8 \cdot 10^0$$

$$a_2 = 1.541\,743\,7 \cdot 10^1$$

$$a_3 = -3.578\,985\,3 \cdot 10^1$$

$$a_4 = 7.149\,912\,5 \cdot 10^1$$

$$a_5 = -1.041\,437\,9 \cdot 10^2$$

$$a_6 = 1.051\,853\,8 \cdot 10^2$$

$$a_7 = -6.944\,376\,7 \cdot 10^1$$

$$a_8 = 2.683\,308\,7 \cdot 10^1$$

$$a_9 = -4.587\,570\,9 \cdot 10^0$$

#### 2 Background to the PLTS-2000

The melting pressure of  $^3\text{He}$  was chosen as the property on which the extension of the ITS-90 should be based because of the sensitivity and reliability with which it may be measured over a wide range (covering more than three decades of temperature) apart from a narrow region around the pressure minimum at 315.24 mK (see Figure). The pressure minimum itself has the compensating advantage of providing a convenient pressure fixed point for calibrating the pressure transducer (the pressure must be measured using

a transducer *in situ* because for temperatures below the minimum a sensing line will be blocked with solid  $^3\text{He}$  and the cell is therefore isolated).

The pressure minimum is one of four natural features which may be located and used as fixed points of pressure and temperature, the others being the transition to the superfluid 'A' phase, the 'A to B' transition in the superfluid and the Néel transition in the solid. The pressure and temperature values of these four points on the PLTS-2000 are:

Point	$p/\text{MPa}$	$T_{2000}/\text{mK}$
minimum	2.931 13	315.24
A	3.434 07	2.444
A-B	3.436 09	1.896
Néel	3.439 34	0.902

The standard uncertainty of the scale in thermodynamic terms is estimated to be 0.5 mK down to 500 mK, decreasing linearly to 0.2 mK at 100 mK. It decreases further with falling temperature, but in percentage terms it increases to about 0.3 % of  $T$  at 25 mK and 2% of  $T$  at 0.9 mK. The standard uncertainties in the absolute pressures are estimated to be about 60 Pa (in about 3 MPa).

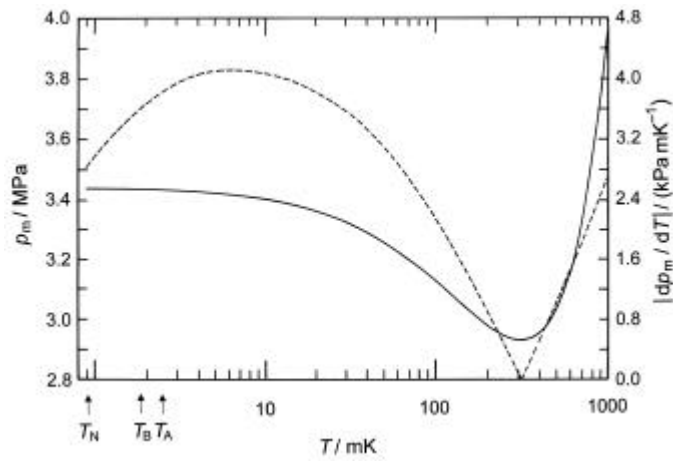


Figure : The  $^3\text{He}$  melting pressure  $p$  (full line) and the absolute value of the derivative  $dp/dT$  (dashed line) vs. temperature.  $T_N$ ,  $T_B$  and  $T_A$  indicate the temperatures of three phase transitions in solid or liquid  $^3\text{He}$ .

## LIST OF ACRONYMS USED IN THE PRESENT VOLUME

### 1 Acronyms for laboratories, committees and conferences

APMP	Asia/Pacific Metrology Programme
BEV	Bundesamt für Eich- und Vermessungswesen, Vienna (Austria)
BIML	Bureau International de Métrologie Légale
BIPM	Bureau International des Poids et Mesures
BNM	Bureau National de Métrologie, Paris (France)
BNM-INM	Bureau National de Métrologie, Institut National de Métrologie, Paris (France)
BNM-LNE	Bureau National de Métrologie, Laboratoire National d'Essais, Paris (France)
CC	Consultative Committee
CCAUV	Consultative Committee for Acoustics, Ultrasound and Vibration
CCDM*	Consultative Committee for the Definition of the Metre, see CCL
CCDS*	Consultative Committee for the Definition of the Second, see CCTF
CCE*	Consultative Committee for Electricity, see CCEM
CCEM	(formerly the CCE) Consultative Committee for Electricity and Magnetism
CCEMRI*	Consultative Committee for Standards of Ionizing Radiation, see CCRI
CCL	(formerly the CCDM) Consultative Committee for Length
CCM	Consultative Committee for Mass and Related Quantities
CCPR	Consultative Committee for Photometry and Radiometry
CCQM	Consultative Committee for Amount of Substance
CCRI	(formerly the CCEMRI) Consultative Committee for Ionizing Radiation
CCT	Consultative Committee for Thermometry
CCTF	(formerly the CCDS) Consultative Committee for Time and Frequency
CCU	Consultative Committee for Units
CEM	Centro Español de Metrología, Madrid (Spain)

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\* Organizations marked with an asterisk either no longer exist or operate under a different acronym

CENAM	Centro Nacional de Metrología, Mexico (Mexico)
CGPM	Conférence Générale des Poids et Mesures
CIPM	Comité International des Poids et Mesures
CMA/MIKES	Mittatekniikan Keskus/Centre for Metrology and Accreditation, Helsinki (Finland)
CMI	Ceský Metrologický Institut/Czech Metrological Institute, Prague and Brno (Czech Rep.)
CODATA	Committee on Data for Science and Technology
COMAR	Code of Reference Materials, International Data Bank on Reference Materials of the BNM-LNE
CPEM	Conference on Precision Electromagnetic Measurements
CRL	Communications Research Laboratory, Tokyo (Japan)
CSIR-NML	Council for Scientific and Industrial Research, National Metrology Laboratory, Pretoria (South Africa)
CSIRO-NML	Commonwealth Scientific and Industrial Research Organization, National Measurement Laboratory, Lindfield (Australia)
DFM	Danish Institute of Fundamental Metrology, Lyngby (Denmark)
DPLA	Danish Primary Laboratory for Acoustics, Lyngby (Denmark)
EC	European Communities
EUROMET	European Collaboration in Measurement Standards
GUM	Główny Urząd Miar/Central Office of Measures, Warsaw (Poland)
IAG	International Association of Geodesy
ICAG	International Conference of Absolute Gravimeters
IEC	International Electrotechnical Commission
IEN	Istituto Elettrotecnico Nazionale Galileo Ferraris, Turin (Italy)
IERS	International Earth Rotation Service
IGS	International GPS Service for Geodynamics
ILAC	International Laboratory Accreditation Conference
IMEKO	International Measurement Confederation
IMGC	Istituto di Metrologia G. Colonnetti, Turin (Italy)
INM*	Institut National de Métrologie, Paris (France), see BNM-INM
INTI	Instituto Nacional de Tecnología Industrial, Buenos Aires (Argentina)
IPCC	Intergovernmental Panel on Climate Change, see WMO
IPQ	Instituto Português da Qualidade, Lisbon (Portugal)

ISO	International Organization for Standardization
ISO-REMCO	International Organization for Standardization, Committee on Reference Materials
IUGG	International Union of Geodesy and Geophysics
IUPAC	International Union of Pure and Applied Chemistry
JCGM	Joint Committee for Guides in Metrology
JCRB	Joint Committee of the Regional Metrology Organizations and the BIPM
JILA	Joint Institute for Laboratory Astrophysics, Boulder CO (United States)
KRISS	Korea Research Institute of Standards and Science, Taejon (Rep. of Korea)
LGC	Laboratory of the Government Chemist, Teddington (United Kingdom)
LNE*	Laboratoire National d'Essais, Paris (France), see BNM-LNE
LNEC	Laboratório Nacional de Engenharia Civil, Caparica (Portugal)
Metas	(ex OFMET) Office Fédéral de Métrologie et d'Accréditation, Wabern (Switzerland)
MIKES	Mittatekniikan Keskus, Helsinki (Finland), see CMA
MRA	Mutual Recognition Arrangement
NCM	National Centre of Metrology, Sofia (Bulgaria)
NIM	National Institute of Metrology, Beijing (China)
NIST	National Institute of Standards and Technology, Gaithersburg MD (United States)
NMI	National Metrology Institute
NMi-VSL	Nederlands Meetinstituut, Van Swinden Laboratorium, Delft (The Netherlands)
NML	see CSIR
NML	see CSIRO
NPL	National Physical Laboratory, Teddington (United Kingdom)
NPLI	National Physical Laboratory of India, New Delhi (India)
NRC	National Research Council of Canada, Ottawa (Canada)
NRLM	National Research Laboratory of Metrology, Tsukuba (Japan)
OFMET*	Office Fédéral de Métrologie/Eidgenössisches Amt für Messwesen, Wabern (Switzerland), see Metas
OIML	Organisation Internationale de Métrologie Légale
PSB	Singapore Productivity and Standards Board (Singapore)

PTB	Physikalisch-Technische Bundesanstalt, Braunschweig and Berlin (Germany)
RMO	Regional Metrology Organization
SMU	Slovenský Metrologický Ústav/Slovak Institute of Metrology, Bratislava (Slovakia)
UME	Ulusal Metroloji Enstitüsü/National Metrology Institute, Marmara Research Centre, Gebze-Kocaeli (Turkey)
USNO	U.S. Naval Observatory, Washington DC (United States)
VNIIFTRI	All-Russian Research Institute for Physical, Technical and Radiophysical Measurements, Gosstandart of Russia, Moscow (Russian Fed.)
VNIIM	D.I. Mendeleyev Institute for Metrology, Gosstandart of Russia, St Petersburg (Russian Fed.)
VNIIMS	Russian Research Institute for Metrological Service of Gosstandart of Russia, Moscow (Russian Fed.)
VSL*	Van Swinden Laboratorium, Delft (The Netherlands), see NMI-VSL
WGDM	CCL Working Group on Dimensional Metrology
WGMP	CCL Working Group for the <i>Mise en Pratique</i>
WMO	World Meteorological Organization
WTO	World Trade Organization

## 2 Acronyms for scientific terms

CMC	Calibration and Measurement Capability
DNA	Desoxyribonucleic acid
GLONASS	Global Navigation Satellite System
GPS	Global Positioning System
GUM	Guide to the expression of uncertainty in measurement
ITS-90	International Temperature Scale of 1990
PLTS-2000	Provisional Low Temperature Scale 2000
QHE	Quantum Hall Effect
QHR	Quantum Hall Resistance
SI	International System of Units
SIR	International Reference System for gamma-ray emitting radionuclides
TAI	International Atomic Time
VIM	International vocabulary of basic and general terms in metrology