

**Bureau International des Poids et Mesures**

# **Comité International des Poids et Mesures**

94th meeting (October 2005)

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

To make its work more widely accessible the International Committee for Weights and Measures 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 GENERAL CONFERENCE**

as of 4 October 2005

**Member States of the Metre Convention**

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

**Associates of the General Conference**

Belarus	Kenya
Chinese Taipei	Latvia
Costa Rica	Lithuania
Croatia	Malta
Cuba	Panama
Ecuador	Philippines
Estonia	Slovenia
Hong Kong, China	Ukraine
Jamaica	Viet Nam





## **THE BIPM AND THE METRE CONVENTION**

The International Bureau of Weights and Measures (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 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 International Committee for Weights and Measures (CIPM) which itself comes under the authority of the General Conference on Weights and Measures (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, in 1984 for the laser work and in 1988 for a library and offices. In 2001 a new building for the workshop, offices and meeting rooms 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 International Bureau of Weights and Measures*, 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 president 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 (CEEM), 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: Metrology in chemistry (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 and the CIPM are published by the BIPM in the following series:

- *Report of the meeting of the General Conference on Weights and Measures;*
- *Report of the meeting of the International Committee for Weights and Measures.*

The CIPM decided in 2003 that the reports of meetings of the Consultative Committees should no longer be printed, but would be placed on the BIPM website, in their original language.

The BIPM also publishes monographs on special metrological subjects and, under the title *The International System of Units (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 International Bureau of Weights and Measures*.

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  
INTERNATIONAL COMMITTEE FOR WEIGHTS AND MEASURES**

as of 4 October 2005

**President**

1. E.O. Göbel, President, Physikalisch-Technische Bundesanstalt, Postfach 3345, D-38023 Braunschweig, Germany.

**Secretary**

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

**Members**

3. S. Bennett, Deputy Director and Director International Metrology, National Physical Laboratory, Teddington TW11 0LW, United Kingdom.
4. K. Carneiro, Director, Danish Institute of Fundamental Metrology, Building 307, Matematiktorvet, DK-2800 Lyngby, Denmark.
5. Chung Myung Sai, President, University of Science and Technology, 52 Eoeun-dong, Yuseong-gu, Daejeon 305-333, Rep. of Korea.
6. L. Énard, Director of scientific research and technology, Laboratoire National de Métrologie et d'Essais, 1 rue Gaston Boissier, 75015 Paris, France.
7. Gao Jie, Emeritus Director, National Institute of Measurement and Testing Technology, P.O. Box 659, Chengdu 610061, Sichuan, China.
8. F. Hengstberger, CSIR – National Metrology Laboratory, P.O. Box 395, Pretoria 0001, South Africa.
9. B. Inglis, Executive Director and Chief Metrologist, National Measurement Institute, P.O. Box 264, Lindfield NSW 2070, Australia.  
*Vice-President.*
10. L.K. Issaev, Deputy Director, VNIIMS, Russian Research Institute for Metrological Service, 46 Ozernaya, 119361 Moscow, Russian Fed.
11. S. Leschiutta, Istituto Nazionale di Ricerca Metrologica, Strada delle Cacce 91, I-10135 Turin, Italy.
12. J. Luszyk, senior adviser, Nanotechnology Research Program Support Office, National Research Council of Canada, Ottawa ON K1A 0R6, Canada.

13. G. Moscati, INMETRO and Instituto de Fisica, University of São Paulo, Caixa Postal 66318, 05315-970 São Paulo SP, Brazil. *Vice-President.*
14. W. Schwitz, Director, Swiss Federal Office of Metrology, Lindenweg 50, CH-3003 Bern-Wabern, Switzerland.
15. H. Semerjian, Acting Director, National Institute of Standards and Technology, Gaithersburg, MD 20899-1000, United States.
16. M. Tanaka, Director National Metrology Institute of Japan, Tsukuba Central 3-9, 1-1 Umezono, Tsukuba, Ibaraki 305-8563, Japan.
17. H. Ugur, Ankara CAD. Mimoza Apt. 50/19, Pendik 34890, Turkey.
18. J. Valdés, Director of Metrology, Quality and Certification, Instituto Nacional de Tecnología Industrial, INTI – Parque Tecnológico Miguelete, av. Gral. Paz e/Albarellos y Constituyentes (B1650KNA), C.C. 157 (B1650WAB) San Martín, Province of Buenos Aires, Argentina.

#### **Honorary members**

1. E. Ambler, 300 Woodhaven Drive, Apt. 5301, Hilton Head Island, SC 29928, United States.
2. W.R. Blevin, 61 Boronia Avenue, Cheltenham NSW 2119, Australia.
3. J. de Boer, Institute of Physics, University of Amsterdam, Valckenierstraat 65, Amsterdam-C, The Netherlands.
4. L.M. Branscomb, Box 309, Concord, Massachusetts 01742, United States.
5. J.V. Dunworth, Apt. 902, Kings Court, Ramsey, Isle of Man, United Kingdom.
6. K. Iizuka, Japan Association for Metrology Promotion, 25-1 Nandocho, Shinjuku-ku, Tokyo 162-0837, Japan.
7. D. Kind, Knappstrasse 4, 38116 Braunschweig, Germany.
8. H. Preston-Thomas, 1109 Blasdell Avenue, Ottawa K1K 0C1, Canada.
9. J. Skákala, Professor, Slovak Technical University, Nám. Slobody 17, 812 31 Bratislava, Slovakia.

**STAFF OF THE  
INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES**

on 1 January 2006

**Director:** Prof. A.J. Wallard

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

Ms P. Barat, Dr H. Fang, Mrs C. Goyon-Taillade, Mr A. Picard

**Time, frequency and gravimetry:** Dr E.F. Arias

Mr R. Felder, Dr Z. Jiang, Mrs H. Konaté, Mr J. Labot,  
Dr W. Lewandowski, Prof. L.-S. Ma<sup>1</sup>, Dr G. Petit, Dr L. Robertsson,  
Mr L. Tisserand, Dr L.F. Vitushkin, Dr P. Wolf

**Electricity:** Dr T.J. Witt

Dr M. Stock<sup>2</sup>  
Mr R. Chayramy, Mr F. Delahaye, Mr R. Goebel, Mr A. Jaouen,  
Dr D. Reymann, Mr S. Solve

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

Dr D.T. Burns, Mr S. Courte, Mrs C. Kessler, Dr C. Michotte,  
Mr M. Nonis, Dr S. Picard, Dr G. Ratel, Mr P. Roger

**Chemistry:** Dr R. Wielgosz

Ms A. Daireaux, Dr M. Esler, Dr R. Josephs, Mr P. Moussay, Dr J. Viallon,  
Dr S. Westwood

**Publications and Information technology:** Dr J. Williams

Mr L. Le Mée, Dr J.R. Miles, Mr G. Petitgand

**BIPM key comparison database:** Dr C. Thomas<sup>3</sup>

Dr S. Maniguet

**Quality systems, ISO and ILAC liaison:** Dr R. Köhler

**Secretariat:** Mrs F. Joly

Mrs C. Fellag-Ariouet, Mrs D. Le Coz<sup>3</sup>, Mrs G. Négadi, Mrs J. Varenne

**Finance, administration and general services:** Mrs B. Perent

Mr F. Ausset, Mrs D. Etter, Mrs M.-J. Martin, Mrs D. Saillard<sup>3</sup>

*Caretakers:* Mr and Mrs Dominguez<sup>4</sup>, Mr and Mrs Neves<sup>4</sup>

*Housekeepers:* Mrs A. Da Ponte, Mrs M.-J. Fernandes

*Gardeners:* Mr C. Dias-Nunes, Mr A. Zongo<sup>4</sup>

**Workshop and site maintenance:** Mr J. Sanjaime

*Workshop:* Mr F. Boyer, Mr M. de Carvalho, Mr J.-B. Caucheteux,

Mr S. Segura

*Site maintenance:* Mr P. Benoit, Mr P. Lemartrier

**Emeritus directors:** Prof. P. Giacomo, Dr T.J. Quinn

---

1 Senior Research Fellow.  
2 Head of special projects.  
3 Also Publications.  
4 Also site maintenance.



**International Committee  
for Weights and Measures**

**Proceedings of the sessions  
of the 94th meeting  
(4 – 7 October 2005)**

## Agenda

1. Opening of the meeting; quorum; agenda.
2. Report of the Secretary and activities of the bureau of the CIPM (October 2004 – September 2005).
3. Membership of the CIPM and other matters.
4. Follow-up to the 22nd CGPM.
5. The CIPM Mutual Recognition Arrangement.
6. SI Brochure.
7. Consultative Committees.
8. Joint Committee for Traceability in Laboratory Medicine.
9. Report from the meeting of NMI directors 2005.
10. Metre Convention/ILAC Joint Working Group.
11. Materials metrology and the Metre Convention.
12. Contacts with other international organizations.
13. Joint Committee for Guides in Metrology.
14. Work of the BIPM.
15. Preparation for the 23rd General Conference.
16. *Metrologia*.
17. Administrative and financial affairs.
18. Other business.
19. Date of next meeting.

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

The International Committee for Weights and Measures (CIPM) held its 94th meeting from Tuesday 4 October to Friday 7 October 2005 at the Pavillon de Breteuil, Sèvres.

Present: S. Bennett, K. Carneiro, Myung Sai Chung, L. Énard, Gao Jie, E.O. Göbel, F. Hengstberger, B. Inglis, L.K. Issaev, R. Kaarls, S. Leschiutta, J. Luszyk (present on Thursday 6 and Friday 7 October), G. Moscati, W. Schwitz, H. Semerjian, M. Tanaka, J. Valdés, A.J. Wallard (Director of the BIPM).

Also attending: P. Giacomo and T.J. Quinn (Emeritus directors of the BIPM); I.M. Mills (President of the CCU, present for part of the meeting); B. Perent (Administrator of the BIPM); F. Joly, D. Le Coz, J.R. Miles (secretariat); also in attendance for parts of the meeting, J.H. Williams (Head of Publications), R. Köhler (Quality System and Liaison with ISO and ILAC) and the following Executive Secretaries of the Consultative Committees and JCGM contact persons: P.J. Allisy-Roberts, E.F. Arias, R.S. Davis, F. Delahaye, R. Felder, C. Michotte, M. Stock, C. Thomas, R.I. Wielgosz, T.J. Witt.

Prof. Göbel, President of the CIPM, opened the 94th meeting by welcoming all present. He presented the apologies of Prof. Ugur, and noted that Dr Luszyk would be joining the meeting on Thursday 6 October. With sixteen members present, the quorum was satisfied according to Article 12 of the Rules annexed to the Metre Convention.

The agenda for the meeting was adopted, and the report of the 93rd meeting approved. 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 2004 – September 2005)**

All the important matters arising in the report of the Secretary are taken up later in the meeting. References are made in this section to the point in the subsequent discussion at which this occurs.

**2.1 Meetings of the bureau of the CIPM**

The bureau met three times during the year. The 2005 meetings in October 2004 and March 2005 were at the Pavillon de Breteuil in Sèvres, and the May 2005 meeting at the PTB in Braunschweig, Germany.

**2.2 Member States of the Metre Convention**

There are still 51 Member States.

At present, the five following States have financial arrears of more than three years: Cameroon, the Dominican Republic, the Islamic Republic of Iran, the Democratic People's Republic of Korea, and Uruguay (although the agreed rescheduling of their debts enables Uruguay to take advantage of the benefits on Membership).

The proposal made last year to the Government of the Islamic Republic of Iran for repayment of their arrears over a period of up to ten years, remains under consideration by the Iranian Government.

Discussions continue with a number of Member States currently in arrears and significant progress has been made in several cases.

Concerning the discretionary contribution we are, despite several reminders, still expecting formal replies from twelve Member States as to whether or not they will pay their discretionary contributions to the BIPM dotation. For the year 2005, the confirmations received to date concerning a decision to pay the discretionary contribution indicate that we may count on more than 80 % of the calculated discretionary amount being paid. Some countries have, due to national regulations, to reconfirm the discretionary contribution every new fiscal year. See also section 17.2.

### **2.3 Associates of the CGPM**

There are now 19 Associates of the CGPM.

New Associates since the last CIPM meeting are Croatia, Estonia and Kazakhstan. We expect a continued steady increase of the number of Associates in the coming years. Discussions continue with CARICOM and we expect their definitive application in the very near future (see also section 5.1.5).

The directors of the NMIs from 18 Associates have signed the CIPM MRA.

### **2.4 Membership and officers of the International Committee**

There have been no changes to the membership of the CIPM since the last meeting. The bureau considered a number of matters relating to the criteria for membership of the CIPM and this will be reported separately to the Committee (section 3).

### **2.5 Consultative Committees**

The bureau has finalized a document on the general rules and policy of the Consultative Committees, which is submitted for approval by the CIPM (section 7.8).

### **2.6 The CIPM Mutual Recognition Arrangement**

See also section 5 below.

#### **2.6.1 CIPM MRA progress reports**

The bureau received regular reports on the position of the CIPM MRA. The MRA has now been signed by representatives from 45 Member States, 18 Associates of the CGPM and two international organizations. These signatures represent about 160 NMIs and other Designated Institutes (DIs) operating under the CIPM MRA.

The transitional period for full implementation of the Quality Systems by the NMIs and other Designated Institutes ended at 31 December 2004. Final review and approval of the Quality Systems of the NMIs and other Designated Institutes by the RMOs should have taken place before 1 April 2005. The Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB), at its 14th meeting in May 2005 in Minsk (Belarus),

confirmed the deletion of a number of CMCs from laboratories that had not yet obtained a positive review of their Quality System (QS). These CMCs are ready to be re-instated when the appropriate reviews have been completed. NMIs and other Designated Institutes, that have CRMs mentioned in the Appendix C of the CIPM MRA as the means of delivering traceability to their customers in the field of metrology in chemistry under the CCQM, must have a QS complying with ISO/IEC 17025 and ISO Guide 34. In this case, full compliance is required by the 31 December 2005 and review and approval of this Quality System by the RMOs should take place before 1 April 2006.

At its September 2005 meeting the JCRB also discussed:

- a new explanation for Calibration and Measurement Capability, with the aim of making the CIPM MRA more transparent and useful for the user community, in particular the accreditation bodies;
- the CMC approval processes in the different RMOs, and the criteria that should be used to assess CMC claims in the absence of the results of key or other relevant comparisons;
- the processes currently being used to review Quality Systems and a harmonization of the treatment of laboratories which choose either accreditation or self declaration to demonstrate compliance with the requirements of the CIPM MRA;
- processes, criteria for peer assessors and points to consider in the case of an on-site peer assessment; and
- the CIPM MRA logo which is to be made available for use by NMIs and other Designated Institutes on their calibration certificates.

#### 2.6.2 CIPM MRA documents

The bureau and the JCRB collaborated on the review of the following documents, which relate to the CIPM MRA. They are presented during this meeting for the CIPM's final endorsement:

- Services available to Associate States and Economies of the CGPM and their participation in the CIPM MRA ([CIPM/2005-05](#));
- The CIPM MRA interpretation document ([CIPM/2005-06](#));
- NMIs and other Designated Institutes ([CIPM/2005-07](#));
- Guidelines for the Acceptance of Certified Reference Materials in Appendix C of the CIPM MRA ([CIPM/2005-08](#));

- Subcontracting of measurements under the CIPM MRA ([CIPM/2005-09](#)).

### 2.6.3 JCRB Executive Secretary

The bureau noted, with appreciation, the contributions of Dr Ismael Castelazo (CENAM) on the completion of his period of secondment to the post of JCRB Secretary. His replacement, Dr Pedro Espina, comes from NIST. The Director of the BIPM and the bureau are grateful to these two NMIs for the secondment of their staff in this way.

## 2.7 BIPM affairs

### 2.7.1 The Quality System of the BIPM

The Director of the BIPM has reported to the bureau on the state of the BIPM's Quality System (QS) and the Secretary of the CIPM has again attended the annual management review of the QS in August 2005. The QS is working well and a number of improvements to procedures have been introduced during the year. Internal audits have continued and preparations are well in hand for the inclusion of TAI and the work of the Chemistry section into the QS. The Director of the BIPM is also considering the further extension of the QS to other areas of the BIPM's work. The second full, external, peer review of those measurement services for which a calibration certificate or a study note is issued, and the QS framework itself, is planned for 2006.

### 2.7.2 Staff recruitments

The bureau agreed with the proposal from the Director of the BIPM that there should be three additional staff recruitments:

- an experienced physicist to strengthen the Electricity section in the light of forthcoming retirements and the CCEM's concern about the resources available to deliver the current programme of work;
- a part-time member of the Secretariat to increase the services available to Committees, the website and the BIPM's scientific work; and
- a deputy to the administrator, assuring continuity, broadening the scope of expertise desirable for running the BIPM (for example, the need for legal knowledge) and diminishing the existing vulnerable situation.

The bureau also noted the need to recruit, in advance of his retirement, a replacement for Dr Davis as Head of the BIPM's Mass section within the next few years, so that there would be adequate handover of responsibilities when he retires.

### 2.7.3 Refurbishment of the old workshop

The bureau discussed the possibility of the renovation of the old workshop to provide additional meeting rooms, which are greatly needed in order to accommodate the large number of meetings held nowadays at the BIPM. In particular, this will help to reduce travelling costs and optimize the opportunities for cross fertilization of the many Consultative Committee working groups which organize their meetings in parallel at the BIPM. The bureau approved a proposal for renovation of part of the old workshop in the Petit Pavillon.

### 2.7.4 Pension fund

An actuarial study of the BIPM pension fund has been carried out and the results will be presented to the Committee (section 17.6).

### 2.7.5 Salary and promotion system of the BIPM

The bureau reviewed the system of promotion of the staff of the BIPM.

## 2.8 Relations with other bodies

See also section 12 below.

### 2.8.1 CIPM/ILAC/OIML discussions

The annual tripartite meeting was held in March 2005 and provided the usual helpful review of activities. The relationship with OIML continues to be strong and there may be opportunities for further collaboration as the International Organization of Legal Metrology (OIML) introduces its Mutual Acceptance Arrangement (MAA). Together with OIML and the International Laboratory Accreditation Cooperation (ILAC), and further to Resolution 6 of the 22nd CGPM, a draft document has been drawn up on the importance of the CIPM MRA, the ILAC Arrangement and the OIML



MAA. The document invites governments to commit to use the relevant Mutual Recognition Arrangements wherever measurements are required in regulation, legislation and the pursuit of human wellbeing at the national and international level. The document has now been completed, following some comments from the OIML and is presented to the CIPM for approval (section 4.1).

### 2.8.2 International Laboratory Accreditation Cooperation

There have been a number of interactions with ILAC over the year, designed at implementing the Memorandum of Understanding (MoU) between the two bodies and at reinforcing the complementarity of the CIPM MRA and the ILAC Arrangement. The Joint CIPM/ILAC Working Group has developed a joint statement on the roles and responsibilities of NMIs and National Accreditation Bodies (NABs). This has been recently approved by the CIPM by correspondence and has been presented to NMI directors and to the ILAC Executive Committee. When approved by both organizations, the document will be sent to a range of organizations including international and intergovernmental bodies with an interest in traceable measurements and measurement uncertainty statements. The outcome of the document should be a close working arrangement between scientific metrology and accreditation at the international, regional and national levels, and should help reinforce the coherence of traceable measurements world-wide. Specifically, it makes a number of recommendations for collaboration and greater use of the CIPM MRA by accreditation bodies and has also created the basis for collaboration between regional metrology organizations (RMOs) and regional accreditation bodies (RABs). To facilitate and bring the different parties together, in March 2005 the BIPM hosted the first joint meeting of the BIPM, ILAC, RMOs and RABs.

### 2.8.3 International Organization for Standardization

The bureau has kept in close touch with events concerning the Metre Convention and ISO. Both ISO and IEC have now unanimously approved the use of the dot and comma as the decimal sign, in conformity with Resolution 10 of the 22nd CGPM. Discussions continue with ISO over the publication of the VIM and the GUM supplements (section 2.9.1). The discussions with ISO CASCO with respect to whether calibration is

conformity assessment or not (see Resolution 11 of the 22nd CGPM in 2003) has led to a compromise wording of the ISO standard 17011, although the wording does not fully reflect our position. Cooperation in the ISO CASCO Working Group 23 has led to an internal ISO CASCO document on impartiality based on case by case risk analysis, that is in agreement with the views expressed by the NMIs. This internal document is a guideline for later updates of ISO CASCO standards.

#### 2.8.4 Codex Alimentarius Commission

The BIPM's observer status of the Codex Alimentarius Commission and its membership of the Inter Agency Meeting enables much closer technical contact with the food safety and nutritional sector than in the past and we are currently building up our collaborations, especially through the comparisons and studies organized by the CCQM and its working groups.

#### 2.8.5 World Trade Organization

Despite the Director's presentation to the World Trade Organization (WTO) Committee on Technical Barriers to Trade last year, there has been little contact from WTO.

#### 2.8.6 World Health Organization

There have been some useful working level contacts between the BIPM and the World Health Organization (WHO), especially with the National Institute of Biological Standards and Control in the UK, which is a major WHO laboratory. As a result, there is much greater appreciation on the need for traceable measurements and measurement uncertainty statements in this community and we hope for continued progress in this important collaboration. The WHO still has internal legal difficulties in becoming formally associated with the JCTLM although collaboration is good at the technical level.

## 2.9 Joint Committees

### 2.9.1 Joint Committee for Guides in Metrology: the VIM and the GUM

The members of Joint Committee for Guides in Metrology (JCGM) are considering the current drafts of the *International Vocabulary of Basic and General Terms in Metrology* (VIM) and the supplements to the *Guide to the Expression of Uncertainty in Measurement* (GUM). The GUM group have made good progress on finalizing the supplements and the VIM Working Group is still considering the many comments they received on their earlier draft. Both groups should have finished their work by the end of 2005. The Director, as Chair of the JCGM, has convened the first meeting of this committee for a number of years; it will meet at the end of November. The main issues for discussion will be the state of the JCGM Charter, publication policy, and a review of the working groups' procedures. Our preferred policy with respect to the publication of the Guides is that these Guides should be freely available via the internet (section 13).

### 2.9.2 Joint Committee on Coordination of Assistance to Developing Countries in Metrology, Accreditation and Standardization

We are still involved with the work of this committee, but with a lower level of resourcing. UNIDO is promoting the "MAS" package to aid agencies and development banks, and a joint policy paper on MAS infrastructures is available on the Joint Committee on Coordination of Assistance to Developing Countries in Metrology, Accreditation and Standardization (JCDCMAS) website. Some PowerPoint presentations clarifying the coherence in activities of metrology, accreditation and standardization are being prepared. These presentations can be used in developing countries as well as in discussions with development aid organizations.

The Chair is currently held by the OIML. During a meeting in March 2005 concerns were expressed about the lack of progress by the JCDCMAS.

### 2.9.3 Joint Committee on Traceability in Laboratory Medicine

The Joint Committee on Traceability in Laboratory Medicine (JCTLM) is working well and is developing its technical work on the listing of reference materials and reference methods/procedures of higher order and

measurement services of potential, competent reference laboratories. It has also formalized its working procedures in a quality manual.

The European Commission is considering how it could make use of the JCTLM work. There is a separate report from the Head of the BIPM Chemistry section on the work of this committee under item 8 of the agenda.

#### **2.10 Materials metrology**

After the first discussions on materials metrology during the meeting of the CIPM in 2004, the Secretary of the CIPM and the Director of the BIPM attended a meeting at the BIPM with various interested parties, representing some NMIs and organizations such as ANMET and VAMAS. As a result Dr S. Bennett has prepared a report which will be discussed under item 11 of the agenda.

In September 2005 the ANMET chairman, Dr G.W. Bahng visited the BIPM and discussed again the need for activities in the field of materials metrology with the Secretary of the CIPM and the Director of the BIPM.

#### **2.11 Directors' Meeting**

A meeting of directors of NMIs was held on 29 and 30 September 2005. This year, the bureau decided that it should focus on the new needs and opportunities for chemical and engineering materials metrology as part of the preparations for the CGPM in 2007. An oral report will be made under item 9.

#### **2.12 World Metrology Day**

The BIPM Director promoted World Metrology Day 2005 (20 May) through a message on the BIPM website with the theme "Global Confidence through SI Traceability". This was well received by many NMIs and was used on several occasions to promote metrology through national events. There should be a similar message for 2006, and a number of NMIs have asked to be sent the message well in advance as to facilitate the organization of their national events.

### 2.13 Financial report

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

Accounts	2002	2003	2004	2005
I. Ordinary funds	6 849 066.09	6 796 242.47	6 716 177.48	6 656 826.81
II. Pension fund	10 547 903.46	10 895 038.83	11 240 366.44	11 260 670.61
III. Special fund for the improvement of scientific equipment	0.00	0.00	0.00	0.00
IV. Staff loan fund	194 983.92	202 427.33	209 624.60	217 347.38
V. Building reserve fund	0.00	0.00	0.00	0.00
VI. <i>Metrologia</i>	0.00	0.00	0.00	0.00
VII. Medical insurance reserve fund	653 741.11	630 883.82	609 069.49	586 449.25
Totals	18 245 694.58	18 524 592.45	18 775 238.01	18 721 294.05

Prof. Göbel thanked Dr Kaarls for his report and invited questions. The issue of discretionary contributions to the BIPM dotation was discussed under Administrative Affairs (item 17.2).

At the request of Dr Schwitz, Dr Kaarls circulated copies of the ISO document mentioned at the end of point 2.8.3. He confirmed that it was a “guideline” rather than a “standard”, and as such was an internal document but he had the right to distribute it.

Prof. Issaev queried the timetable for completion of the revised draft of the VIM (section 2.9.1), and Dr Kaarls confirmed that the Director had sent a message to the working group concerned, JCGM-WG2, to request they complete their work before the end of 2005. Prof. Giacomo, Chairman of the working group, commented that progress by this committee had been very slow, and that some of the new definitions were difficult to understand. Reports from both JCGM working groups are presented in section 13.

Dr Tanaka requested further information about the JCDCMAS. Dr Kaarls replied that the JCDCMAS had met in March 2005, and that several of the member organizations had expressed the position that the activity should be stopped if no progress was made before March 2006. He added that cooperation between the members was proving unsatisfactory, and there were some vested interests rather than provision of a balanced MAS message.

Dr Hengstberger emphasized the importance of delivering a balanced message on MAS, warning that developing countries often invested 90 % of their available resources into setting up standards organizations, and pointing out that these were, on their own, insufficient to provide international traceability. He welcomed the proposal to produce JCDCMAS PowerPoint presentations, and urged the CIPM to continue their efforts in this area. Dr Tanaka agreed that the activities under the remit of the JCDCMAS, and particularly official donor aid policy, were an essential area for the CIPM to consider; he recommended that if the activities of the JCDCMAS were reduced, then perhaps a CIPM Sub-committee on JCDCMAS related issues should be set up.

### **3 MEMBERSHIP OF THE CIPM AND OTHER MATTERS**

Prof. Göbel noted that there were currently no vacancies on the Committee, but asked if any members intended to resign during the coming year.

During the meeting on Friday 7 October, Dr Luszyk announced his resignation from the Committee with effect from the end of the meeting, explaining that his professional work has taken him out of the world of metrology and into nanotechnology. He thanked the members of the CIPM for their warmth and friendship. On behalf of the CIPM, Prof. Göbel thanked Dr Luszyk for his work on the Committee, saying he had been a very positive member with whom it had been a pleasure to work, and wishing him well in his future career.

Dr Lusztyk's resignation left one vacancy on the Committee. Dr Kaarls reminded the Committee that the rules did not permit an immediate election, and confirmed that a ballot would be organized by postal vote.

The bureau presented a revised set of criteria for CIPM membership, and after minor rewording they were approved by the Committee. The principles followed by the bureau and the CIPM in making elections are henceforth as follows:

- Persons proposed for election are always of a high scientific standing and have experience which qualifies them to take part in the work of the CIPM.
- In accordance with the discussion at the 17th CGPM, the CIPM should – in general – ensure that the candidate is acceptable to his or her government at the time of provisional election. The bureau encourages the members of the CIPM to continue to maintain this relationship throughout their membership of the CIPM.
- Care is taken to ensure an appropriate spread of scientific disciplines.
- Members should be prepared to make a significant contribution of time and effort to the work of the Metre Convention.
- Efforts are made to maintain a reasonable balance between regions and also to ensure the presence of a small number of members from those States paying the minimum contribution.
- Candidates from Member States three or more years in arrears with their payments to the BIPM are not considered for election.
- One member of the CIPM is always of French nationality. This recognizes the role of France as the originator of the metric system and the depository of the Metre Convention.
- One member comes from each State paying the maximum contribution.
- Particular consideration is given to candidates from States which pay a contribution of 2 % or above.

The CIPM then proceeded to a confidential discussion on possible candidates. Dr Hengstberger asked whether, if there were several candidates from one Member State, the national government should be asked to choose one candidate. Prof. Göbel confirmed that this was not necessary.

A summary chart showing all CIPM members since 1875 was distributed and will be published on the BIPM website.

## **4 FOLLOW-UP TO THE 22ND CGPM**

### **4.1 Resolution 6, on the importance of the CIPM MRA**

Prof. Wallard presented for approval the document “Common statement and declaration by the BIPM, OIML and ILAC on the relevance of various international agreements on metrology to trade, legislation and standardization”. This common statement describes the missions of each of the three organizations, and their complementary, mutually supportive work. It also highlights the importance of their Mutual Recognition Arrangements to underpin the unified world-wide metrology system for industry, commerce and international trade. The statement specifically invites governments and other authorities to endorse and commit themselves to use the CIPM MRA, the OIML MAA and the ILAC MRA whenever possible. The intention is to send the document to a variety of international organizations and NMIs, which will take up the issues at the national level. The document presented had already been approved by ILAC and the OIML.

The Committee highlighted the importance of convincing regional regulatory bodies to use the CIPM MRA, and suggested that the President of the CIPM should send copies to the Presidents of the European Commission and other regional regulatory bodies. With the subsequent approval of the OIML and ILAC, the words “national and regional” were inserted in the second point of the declaration, to describe the regulatory bodies. Dr Valdés suggested that “success stories” could be reported on the website, illustrating where implementation of the Arrangements had proved invaluable.

After minor rewording, the Committee gave their formal approval to the text. The revised text of the declaration reads as follows:

In accordance with Resolution 6 of the 22nd General Conference of Weights and Measures, the International Committee for Weights and Measures (CIPM), the International Organization of Legal Metrology (OIML), and the International Laboratory Accreditation Cooperation (ILAC) invite Governments to endorse, and declare their commitment to use and refer to organizations which are signatories to the CIPM MRA, the OIML MAA and the ILAC Arrangement, wherever measurements are required as evidence of



compliance with legislation, regulation or the pursuit of human well-being at a national and international level.

The three bodies further invite standardization organizations, national and regional regulatory and trade bodies to note the existence and value of the above Arrangements, and to collaborate with the three organizations so as to develop ways and means of referring to, promoting, and using the Arrangements in their work.

The full text will be published on the BIPM website.

#### **4.2 Resolution 9, on cross-border transport**

Prof. Wallard reported that Resolution 9 of the 22nd CGPM (2003), on the need to improve cross-border transport of measurement standards, metrological equipment and reference materials, was discussed at the 2005 meeting of the ISO Advisory Committee on Reference Materials (ISO REMCO). In 2001, the ISO REMCO established a working group to investigate closely related problems with the transport of Certified Reference Materials (CRMs). Despite the establishment of a general customs tariff number (3822.00) for CRMs, distribution difficulties remain in the area and direct approaches to the World Customs Organization (WCO) by representatives of ISO REMCO have produced no significant improvements to date. ILAC have separately approached the WCO regarding the related issue of facilitating the international distribution of proficiency test samples, but have been similarly unsuccessful.

The ISO REMCO meeting recommended (in their Resolution 12/2005) a joint approach to the WCO as being the best strategy to achieve progress in this area, involving all interested international organizations including the Metre Convention. Other organizations identified as definitely or potentially interested were IAEA, ILAC, WHO, national Pharmacopoeial bodies and the World Anti Doping Agency (WADA).

A simultaneous approach to the WTO as well as the WCO was recommended. In this regard it is proposed that ISO REMCO will prepare a draft letter for the WCO by October 2005 for distribution for comment from interested parties.

The BIPM will continue to liaise with ISO REMCO on this issue. A position statement will be drawn up before deciding on the next course of action.

#### **4.3 Resolution 10, on the decimal marker**

The CIPM welcomed the news, as mentioned in the Secretary's Report, that in May 2005 ISO had unanimously approved use of either the decimal point or the decimal comma, and the IEC had unanimously approved the same in August 2005.

### **5 THE CIPM MUTUAL RECOGNITION ARRANGEMENT**

#### **5.1 Report on the JCRB**

Prof. Wallard presented a report on the JCRB prepared by Dr P. Espina, Executive Secretary of the JCRB.

##### **5.1.1 Change of Executive Secretary**

On 27 May 2005 Dr Ismael Castelazo concluded his tenure as Executive Secretary of the JCRB and returned to CENAM (Querétaro, Mexico). Dr Pedro Espina (from the NIST, Gaithersburg) started working as the JCRB Executive Secretary on 4 April 2005.

##### **5.1.2 Report on the present status**

The CMC review process continues smoothly with many RMOs taking advantage of the availability of the new "Fast Track" procedure for CMCs that have been pre-reviewed by their peers in other RMOs. In practice, these Fast Track submissions tend to take place immediately after meetings of the CC working groups on CMCs and the CMCs are typically approved within 48 hours.

The JCRB recognizes that the large number of MRA-related documents available in the open section of the JCRB website is leading to some confusion amongst the users of these documents. The JCRB Executive Secretary will be asked to condense the current policy into a small set of up-to-date guides that will be available on an "MRA page" on the BIPM website. When necessary, these new guides will be reviewed and modified on a yearly basis by the JCRB and resubmitted to the CIPM for approval.

The KCDB presently contains over 17 000 approved CMCs in Appendix C and 628 key and supplementary comparisons in Appendix B. As of September 2005, all CCs have working groups on CMCs and the JCRB Executive Secretary attends their meetings to provide advice and aid with the implementation of MRA guidelines and regulations.

#### 5.1.3 End of the transition period

The CIPM MRA transition period ended on 31 December 2004. Henceforth, all NMIs are required to have a fully implemented Quality System supporting their published CMCs. Following the 14th JCRB meeting, 723 CMCs not covered by an approved Quality System were removed from the KCDB.

CMCs related to mass and related quantities are however subject to a deadline of 31 December 2005; the first JCRB meeting of 2006 will deal with these and the other CMCs which now have the approval of the RMOs as far as the supporting Quality System is concerned. Their status will be reported to the CIPM in 2006.

#### 5.1.4 CIPM MRA statement and logo

The JCRB has selected a logo as the emblem to be included in calibration certificates of NMIs which participate in the MRA. It is expected that the logo will increase awareness of the CIPM MRA among regulators.

The logo was further discussed under item 5.4 below.

#### 5.1.5 Criteria for acceptance of data for Appendix C

The JCRB approved a new criterion for acceptance of CMCs to Appendix C of the CIPM MRA after the transition period (see document JCRB-14/06(2a), available on the BIPM website).

Prof. Wallard concluded by reporting that a formal application as an Associate State or Economy of the CGPM had been received from CARICOM, on behalf of 11 of its Member States. In line with the discussions at the 22nd CGPM, he welcomed this in the spirit of making the CIPM MRA as inclusive as possible.

Prof. Göbel thanked Prof. Wallard for his report and invited comments.

Dr Semerjian asked whether concerns had been expressed about the reviews of the Quality Systems in certain RMOs. Prof. Wallard acknowledged they had, and said that this had led to a frank exchange of views. The JCRB has asked the working groups concerned to send representatives to similar meetings in other RMOs, so as to increase understanding and confidence in order to resolve the issues. In general the CMC review process was working well.

## 5.2 Papers approved by correspondence

Prof. Wallard reminded members that during the year 2004-2005 they had approved five papers by correspondence:

- [CIPM/2005-05](#), entitled “Services available to Associate States and Economies of the General Conference on Weights and Measures and their participation in the CIPM MRA”;
- [CIPM/2005-06](#), entitled “The CIPM MRA: Interpretation document”;
- [CIPM/2005-07](#), entitled “NMIs and other designated institutes”;
- [CIPM/2005-08](#), entitled “Guidelines for the acceptance of certified reference materials in Appendix C of the CIPM Mutual Recognition Arrangement”; and
- [CIPM/2005-09](#), entitled “Subcontracting of measurements under the CIPM MRA”.

On [CIPM/2005-05](#), Dr Semerjian remarked that Associates were able to benefit from a large number of the advantages of Member States, and Prof. Wallard agreed that this was in the spirit of the CIPM’s discussions in 2004, to make the CIPM MRA more open to Associates. On the other hand, he noted that Associates did not generally have the right to participate in CIPM key comparisons, and Dr Thomas, Coordinator of the BIPM key comparison database (KCDB), confirmed that where they did, their results were not included in the calculation of the key comparison reference value (KCRV). Prof. Göbel added that Associates could not vote in the CGPM.

A brief discussion ensued on the special case of the CCTF key comparison [CCTF-K2001.UTC](#), on the calculation of the reference time scale UTC. Prof. Leschiutta noted that UTC has been calculated using data from as wide a range of contributors as possible for forty years, and the list of participating laboratories therefore pre-dates the rules of the CIPM MRA. Dr Thomas pointed out that, although in this case the KCRV (UTC itself) includes the results of *all* participating laboratories, only those results from

laboratories participating in the CIPM MRA are published in the KCDB. The CIPM endorsed the current policy on the participation of time laboratories in UTC and [CCTF-K2001.UTC](#).

Dr Semerjian then turned the discussion to [CIPM/2005-06](#), pointing out that the text remained unclear in places. Dr Inglis agreed that it was rather convoluted, and Dr Schwitz pointed out that it was mainly a question of wording, which could be undertaken by a small group. Prof. Göbel agreed that, although the document had already been approved, the bureau should consider further suggestions on improving the wording, particularly from Dr Inglis, Dr Schwitz and Dr Semerjian.

Dr Valdés suggested that all documents should be dated.

### 5.3 The BIPM key comparison database

Dr Thomas summarized a document on the BIPM key comparison database, KCDB. Members expressed their satisfaction that everything was going well.

Appendix B of the KCDB now covers 633 key and supplementary comparisons conducted under the auspices of the CIPM or of RMOs. These include 508 key comparisons, 180 of which have had their results published in the KCDB by 6 September 2005.

Ongoing BIPM key comparisons are regularly updated with the results of new bilateral comparisons carried out between the BIPM and NMIs. New results approved by CCs are still communicated to the BIPM for publication via the KCDB at an average rate of about one per week.

The results of 29 RMO key comparisons (10 conducted by APMP and 19 by EUROMET) are linked to those of the corresponding CC key comparisons; the full sets of degrees of equivalence are published in the KCDB. The same type of linkage has also been carried out for 14 CC key comparisons of activity of radionuclides.

Appendix C now contains about 17 500 Calibration and Measurement Capabilities (CMCs), covering all fields of metrology.

As reported under section 5.1.3, CMCs that were not covered by an approved Quality System were deleted from the KCDB in July 2005. Subsequently, a number of CMCs, especially in the fields of ionizing radiation and time and frequency, have been approved and published.

The work of the KCDB is detailed in nine procedures that successfully passed the BIPM Quality System internal review on 31 May 2005 for the second consecutive year.

The number of external connections to the KCDB website has increased by 35 % over the period August 2004 – March 2005, reaching 8600 visits in March 2005. This trend is shared equally between Appendix B and Appendix C.

The KCDB is publicized through, for example, the distribution of copies of the KCDB leaflet, the presentation of the KCDB website at workshops and congresses, and the electronic *KCDB Newsletter*, which is sent to about 1000 e-mail addresses.

Mr Érard expressed particular thanks to Dr Thomas for all the changes she had had to make to Appendix C following the changes in names of the participating French laboratories. Prof. Göbel added his appreciation of her work and asked about the access statistics. Dr Thomas reported that the most recent data were for the month of March 2005, when there had been 8600 separate visits to the KCDB website.

In answer to a question from Dr Semerjian, Dr Thomas said that a number of CMCs from Canada and Chile had been deleted from Appendix C in July 2005. However, she pointed out that the data remained at the BIPM and could easily be re-inserted when appropriate. She added that the 94 deleted CMCs from South Africa had now been re-inserted following approval of their Quality Systems.

#### 5.4 MRA logo and equivalence statement

Mrs Perent gave a brief presentation on progress with the CIPM MRA logo. She informed the Committee that both the logo of the BIPM and the Metre Convention “*macaron*” are protected by the World Intellectual Property Organization (WIPO) under the terms of article 6 of the *Convention d'Union de Paris*. Protection of these logos means that they can only be used by another party with the express permission of the BIPM.

The BIPM approached WIPO to obtain protection for the logo of the CIPM MRA (an image of the *Pavillon de Breteuil* with a yellow arc around it and the letters CIPM MRA below), but were informed that WIPO are unable to provide such protection, because the CIPM MRA is not a convention between Member States, but a technical arrangement between national metrology institutes.

We have received legal advice that, as the BIPM logo and the CIPM MRA logo use the same figurative element (the Pavillon de Breteuil), the figurative part of the CIPM MRA logo would implicitly benefit from indirect protection within the Member States of WIPO. This group includes all current Member States of the Metre Convention and Associates of the CGPM, apart from Thailand. The abbreviation “CIPM MRA” is not protected, however, and the advice of the lawyers was to apply for registration of the abbreviation “CIPM MRA” as a trademark.

It should be noted that the protection under the *Convention d'Union de Paris* concerns only trademarks but does not apply to services. Therefore we were also advised to register the CIPM MRA logo as a trademark so that we have the monopoly for the use of the logo which would designate specific products and services, and allow distinction from other competitive products and services. Formal registration gives this protection.

The lawyers also indicated how we could proceed with exploitation of the emblem after registration. Two types of registration are possible: (1) *marque individuelle*, which may be used by others but only those expressly chosen and authorized by the BIPM; (2) *marque collective*, which involves use by anybody who respects rules established by the BIPM, in which case there is no control by the BIPM on who uses the logo. It would be more appropriate for us to follow the first route, and to consider establishing a charter between the BIPM and laboratories who wish to use the logo rather than a license between the BIPM and each laboratory. This charter should clearly be mentioned at the time of the registration of the CIPM MRA logo. The final decision of who could use the logo would rest with us and we would treat applications on a case by case basis.

Our legal advisors also indicated the cost of registering the logo, and a first estimate of the cost is of the order of 50 000 euros. This large sum represents only the cost of registering ownership of the logo in each Member State of the Metre Convention and each Associate of the CGPM. It does not include other costs such as translation, reproduction, certification, nor the additional costs that would be incurred if we were forced to defend our ownership, by going to litigation against another body who were seeking to infringe our rights. The cost of such litigation would be significant, and there would be no way of knowing in advance what the final cost of such legal action would be in terms of money or time.

Prof. Göbel thanked Mrs Perent for her presentation, and reported that the bureau of the CIPM had therefore decided not to register the logo and stated

that its use, which is voluntary, should be restricted to those certificates supported by published CMCs. A charter for its use and a list of those NMIs and DIs authorized to use it will be produced and maintained on the BIPM website.

## **5.5 Participation of international/intergovernmental organizations**

Prof. Wallard informed the Committee that discussion were under way with the World Meteorological Organization (WMO) concerning their possible participation in the CIPM MRA.

## **6 SI BROCHURE**

### **6.1 8th edition of the SI Brochure**

Prof. Mills, President of the Consultative Committee for Units (CCU) reported to the CIPM on the final preparations for the new (8th) edition of the SI Brochure.

Chapter 1 is a general introduction to the SI. A brief introduction to the subject of units for biological quantities is given (for the first time) in section 1.6. Although a draft chapter on biological quantities was presented in 2004, reactions to the text were not consistent and the CCU would prefer to include just a short section on this topic at present. The CCU recommended that the CIPM set up a working group of experts on units for biological quantities, to advise on how this subject should be handled in future editions of the SI Brochure.

The wording of the text surrounding the definitions of the base units in Chapter 2 has been modified slightly since the draft version seen by the CIPM in 2004.

There have been a few minor changes in Chapter 4 (on units outside the SI) and Chapter 5 (on how to write symbols for the values of quantities and units in the SI).

Appendix 1, which lists the decisions of the CGPM and the CIPM since 1889, is presented in chronological order. However it now begins with a



detailed subject index so that decisions relating to any particular field can be easily located.

Appendix 2 presents information on the *mise en pratique* for realizing the definitions of some units. As discussed in 2004, this appendix will be entirely transferred to the BIPM website. This will allow future modification to the information at more frequent intervals than the Brochure is ever likely to be revised. The CCU plans that the drafts for the various sections of Appendix 2 will be prepared by the appropriate Consultative Committees, collated by the CCU Executive Secretary, and then reviewed by the President of the CCU before the final text is published on the website.

Appendix 3 is intended to provide information on the relation of CGS-Gaussian quantities and units to the SI. However, Prof. Mills reported that three experts to whom he had sent the text for comments, had again had conflicting views on the subject. He proposed to withdraw the Appendix at present, and consider it again for a future edition.

Prof. Göbel thanked Prof. Mills for his report and invited questions.

Dr Hengstberger was unhappy to see that the chapter on biological quantities had been omitted, and reiterated the CCPR's belief that the text prepared by Dr Bastie on photobiological quantities should be published in the Brochure. It was important, he said, to avoid the proliferation of units for quantities such as ultraviolet exposure, for which international standards have already been published by the International Commission on Illumination (CIE). He pointed out that for photobiological quantities the expert working group was in fact the CCPR, who had approved Dr Bastie's text.

Dr Kaarls was in favour of setting up a working group on units for biological quantities, pointing out that there were many sub-fields, including chemical and acoustic as well as radiometric. Prof. Wallard suggested that Dr Bastie's text on photobiological units, approved by the CCPR, be included as an Appendix in the 8th edition, and that a broader text dealing with biological units in general be prepared as a second document by an appropriate group of experts. This was approved by the CIPM and the bureau will discuss the next steps.

Dr Inglis asked what feedback had been received on the draft Appendix on CGS units. Prof. Mills reported that one of the tables had been considered misleading, and that it was difficult to find words with which all three experts would agree. He felt that the SI Brochure should not be

controversial, and therefore would prefer to withdraw the text for the time being. Prof. Kovalevsky suggested that he present the text for discussion to a group of the French Academy of Sciences, of which he is Chairman; this was accepted. Dr Kaarls also supported the suggestion to remove the Appendix, saying he would like the SI Brochure to concentrate on the International System of Units.

A couple of minor changes to the wording in section 1.3 and Table 8 were suggested by Dr Valdés and approved.

Dr Semerjian commented that the CCU had worked very hard on this new edition, and expressed the appreciation of the CIPM.

## 6.2 The SI mini-brochure

Following the CIPM's comments in 2004 that the SI Brochure was becoming too long and complicated, Prof. Mills reported that the CCU has prepared a draft "mini-brochure", which covers just four A4 pages. This could be made widely available at low cost. He also showed the CIPM a possible "micro-brochure".

Dr Inglis strongly supported both the "mini" and "micro" formats, saying that they would be extremely useful for all the NMIs. Dr Hengstberger agreed, suggesting they could be released on World Metrology Day. Dr Carneiro particularly liked the "micro" version, pointing out that it would be easy to translate into other languages. He added that the A5 brochure "*Metrology – in short*" is available in nine languages, and is often requested for distribution in school classes.

Dr Semerjian agreed that the best impact would be achieved through schools. He suggested that the text could also be provided to publishers of scientific books, who could be encouraged to include it as an appendix. He supported the idea of providing the material free of charge, to encourage its dissemination.

Prof. Göbel noted the Committee's positive reaction to both "Concise summary" and "micro" forms, and encouraged the CCU to continue with their preparation. Prof. Mills anticipates publication of the mini-brochure early in 2006, at the same time as the full SI Brochure.

## 7 CONSULTATIVE COMMITTEES

### 7.1 Consultative Committee for Units

Prof. Mills presented a report of the Consultative Committee for Units (CCU), which had held its 17th meeting from 29 June to 1 July 2005. Besides the discussions on the new edition of the SI Brochure (section 6), the majority of the meeting was devoted to the possibility of redefining the base units of the SI. He commented that there were 35 persons present at this meeting, the largest meeting the CCU has ever had.

In particular the CCU considered whether – and when – it should recommend action to redefine the kilogram, either by fixing the Planck constant,  $h$ , or the Avogadro constant,  $N_A$ ; whether simultaneously to redefine the ampere by fixing the elementary charge,  $e$ , and the kelvin by fixing the Boltzmann constant,  $k_B$ ; finally, if the kilogram were to be redefined by fixing  $h$ , whether simultaneously to redefine the mole by fixing the value of the Avogadro constant. It was noted that redefining the kilogram to fix  $N_A$  would be conceptually simpler and lead to wording for the definition that would be easier to understand. However, redefining the kilogram to fix  $h$  was seen to be closer to the needs of fundamental physics. It would also have a significant advantage if the ampere were simultaneously redefined to fix  $e$ , because then both the Josephson constant,  $K_J = 2e/h$ , and the von Klitzing constant,  $R_K = h/e^2$ , would take exactly defined values, with significant advantages for electrical measurements.

It was the feeling of the meeting that any new definition of the kilogram should wait for new experiments to resolve the present discrepancy of almost  $1 \times 10^{-6}$  between the x-ray crystal diffraction measurements of  $N_A$  and the watt balance measurements of  $h$ . After much discussion the CCU concluded that, rather than redefining the kilogram alone in 2007 as had been proposed by Mills *et al.* (*Metrologia*, 2005, **42**, 81-80), it would like to redefine the kilogram, the ampere, and the kelvin simultaneously, to fix  $h$ ,  $e$ , and  $k_B$ , respectively. Further, if colleagues in the IUPAC were favourable to a redefinition of the mole so as to fix  $N_A$ , then this new definition should also be adopted at the same time.

The CCU concluded that we should plan and prepare to make the changes at the CGPM in 2011, and that the six intervening years should be devoted to careful planning, consideration of all the implications, preparation of the

words and the necessary *mises en pratique* for the new definitions, and discussion with all the various interested parties.

Prof. Mills drew attention to their formal Recommendation U 1 (2005) and commented that the CCU was recommending a small revolution in the SI, which they believed would lead to a stronger and better based system.

Prof. Göbel thanked Prof. Mills for his detailed report and invited discussion, starting with comments on the proposed timescale. There was general agreement that the timescale was reasonable. Dr Semerjian reported that the NIST fully supported the recommendation, but proposed that notice be given at the CGPM in 2007, so that sufficient time was allowed for full discussion and the resolution of remaining scientific issues. Dr Tanaka noted that the issue would also be discussed in the CCM report below, and Prof. Issaev asked whether mention should be made of the associated *mises en pratique*.

Dr Hengstberger commented that the CIPM must be aware that changing the definitions of so many units at once would cause a shock, saying it was important to minimize this, and to ensure that the SI remained as widely accessible as possible.

Prof. Göbel then asked if the CCU foresaw any problems with fixing both  $e$  and  $h$ , in terms of energy scales. Prof. Mills commented that the relative values of the fundamental constants are already well known, but the constants cannot be expressed exactly in terms of the SI and change with successive CODATA updates. Fixing  $e$  and  $h$  would fix the conversion factor between mechanical energy and frequency.

Prof. Göbel remarked that it would be important to consider carefully the consequences of introducing an uncertainty in the kilogram, and Dr Semerjian suggested that the CIPM make a formal request to the Consultative Committees to consider the issue and submit a report. Prof. Mills said the CCU had anticipated this, and prepared a draft recommendation for the CIPM to consider. After further discussion between Prof. Göbel, Prof. Mills and Dr Semerjian, a revised text was proposed to the CIPM, and approved as Recommendation 1 (CI-2005).

Prof. Wallard noted that it was important for the Consultative Committees to discuss the various issues also with other bodies.

## 7.2 Consultative Committee for Amount of Substance: Metrology in Chemistry

Dr Kaarls, President of the Consultative Committee for Amount of Substance: Metrology in Chemistry (CCQM), presented a report on the activities of the CCQM and its working groups.

The CCQM has seven permanent working groups: Working Group on Organic Analysis (OAWG), chaired by Dr W. May, NIST; Working Group on Inorganic Analysis (IAWG), chaired by Dr M. Sargent, LGC; Working Group on Gas Analysis (GAWG), chaired by Dr E. de Leer, NMi VSL; Working Group on Electrochemical Analysis (EAWG), chaired by Dr M. Máriássy, SMU; Working Group on Bioanalysis (BAWG), chaired by Dr H. Parkes, LGC; Working Group on Surface Analysis (SAWG), chaired by Dr W. Unger, BAM; and Working Group on Key Comparisons and CMC Quality (KCWG), chaired by Dr J. McLaren, NRC.

Dr Kaarls pointed out that the number of NMIs and other Designated Institutes in the CCQM working groups increases every year. On a one-off basis other expert laboratories, having very specialized capabilities, competence and useful know-how, are participating in pilot studies. Whenever possible, wider inter-laboratory comparisons and proficiency tests are organized in parallel and connected with the CCQM studies or comparisons. This gives a direct link to global comparability and is a very good way of demonstrating the traceability of field laboratories. Of course, the CCQM does not take itself responsibility for these inter-laboratory comparisons and proficiency test schemes, nor will CCQM itself report on the results.

During the second half year of 2004 the CCQM working groups on inorganic analysis and electrochemical analysis have held their meetings on 27-29 October 2004 at CENAM in Querétaro, Mexico. In addition a workshop on metrology in chemistry has been held.

The CCQM working groups on gas analysis, organic analysis and bioanalysis have held their meetings during the period 20-22 October 2004 at the NRCCRM in Beijing (China), preceded by a large, well attended symposium on metrology in chemistry.

In order to coordinate, to harmonize and to benefit from the knowledge available in other working groups, joint sessions have also been held by the inorganic and electrochemical working groups, the organic and bioanalysis working groups and the organic and gas analysis working groups.

On 13 April 2005 a well-attended CCQM workshop was organized at the BIPM on the topic of “New Challenges for the Development of Primary or Higher Order Measurement Methods and Procedures for Physiologically-Significant Molecules”, addressing topics such as DNA, protein and bioactivity measurements. Speakers came from CENAM, KRIS, LGC, NIST, NPL, PTB, University of Giessen (Germany) and the National Institute of Biological Standards and Control (NIBSC, UK), a major WHO laboratory.

The cooperation with the Codex Alimentarius Commission and its Inter Agency Meeting has been further strengthened. As a result, the CCQM working groups on organic and inorganic analysis have planned a series of studies and key comparisons which may deliver the corner stones for establishing traceability in and by the food sector.

The CCQM Working Group on Organic Analysis has decided on a first list of high-priority studies and comparisons serving the needs of the food sector. The programme of work is further focussing on the needs for traceability in the health-care sector, the environmental sector and the anti-doping sector.

The CCQM Working Group on Inorganic Analysis (IAWG) will carry out comparisons on behalf of the food sector with respect to nitrates and nitrites. The programme of work of the IAWG is further focussing on needs in the environmental area, such as metals and alloys and sulphur in fuels. Isotopic studies are also carried out.

The CCQM Working Group on Electrochemical Analysis has an active programme on pH measurements and electrolytic conductivity measurements with the aim of improving comparability, traceability and fundamental understanding.

The CCQM Working Group on Gas Analysis is running an extensive programme of pilot studies and key comparisons, addressing all areas of gas analysis, including environmental measurements, health care and natural gas.

The CCQM Working Group on Bioanalysis discussed the results and progress of work under way, in particular on DNA related measurement topics and protein measurements.

The CCQM Working Group on Surface Analysis reported good progress in the field of improving comparability in surface analysis. One key comparison and two new studies were approved.

The BIPM programme on metrology in chemistry is planning its future work in organic analysis, in particular purity analysis on theophylline, digoxin and steroid hormones.

Dr Kaarls reported that the WHO and the NIBSC have now an ongoing commitment to work with the metrological community through the CCQM.

He also reported that he has been invited to attend the meeting of, and give a presentation to, the International Association of Forensic Sciences (IAFS) during their summit in Hong Kong in August 2005. The IAFS declared that they need more metrological underpinning of the forensic analysis. These include measurements of DNA, drugs of abuse, poisons and explosives.

Discussions with the World Anti Doping Agency (WADA) have led to a first CCQM comparison on 19-norandrosterone (a major metabolite of nandrolone) in freeze-dried human urine, this being one of the anabolic steroids tested for in sports drug testing.

Dr Bennett asked whether a report would be published on this comparison. Dr Kaarls confirmed that pilot study reports were only published with the agreement of all participants, and additionally it had been agreed in the protocol of the comparison that a report would only be published with the approval of the CCQM.

Dr Schwitz asked what was the status of the COMAR database, and in particular how it related to CMCs. Dr Kaarls explained that the COMAR database for certified reference materials was a non-evaluated list maintained by the Bundesanstalt für Materialforschung und -prüfung (BAM); it has no relation with CMCs. He added it was not of direct interest to the CCQM, although a number of CCQM members have CRMs included in it.

Prof. Göbel noted that the activities of the CCQM were forever growing, and asked if any activities were finishing. Dr Kaarls confirmed that activity was increasing in the area of food analysis but said that great care was taken to undertake only the highest priority comparisons. He added that a second layer of calibration laboratories was missing in the field of chemistry, and this created more demand for NMI-based work.

Prof. Göbel then asked if approaches from other bodies to undertake more work were accompanied by financial contributions. Dr Kaarls confirmed that a financial contribution from the IFCC was received for the JCTLM secretariat, but noted that although it may be possible to attract funding in some cases, there was little chance of doing so from other international organizations.

Dr Semerjian asked if it might be time to split the CCQM into several Committees. He noted that the size of the current CCQM posed logistical problems.

Dr Kaarls agreed that the size posed logistical problems. He had, however, asked the same question of the working group chairs, who were keen to maintain the current situation for the time-being so as to facilitate interactions between the groups.

Prof. Issaev expressed concern that the chemical field was consuming an increasing amount of resources, and cautioned that it was necessary to restrict our activity in this area. He asked how many laboratories had needed the support of the CCQM. Dr Kaarls replied that there were hundreds of thousands of laboratories requiring traceability in amount of substance, including around ten thousand laboratories in the clinical area. He emphasized that although the field of chemistry was not a “black hole” as some have said, the number of chemical measurements is indeed huge; he gave the example of a typical clinical laboratory, which might carry out 10 000 analyses per day. He noted the importance of developing a second layer of calibration laboratories.

Dr Semerjian agreed that the description “black hole” was not appropriate, pointing out that in this case there were lots of things coming out. He recognized the importance of making the system more efficient, however. He noted that the NIST operates a system of NIST Traceable Reference Materials (NTRM<sup>®</sup>s), which are commercially produced reference materials with a well-defined traceability linkage to existing NIST standards.

Dr Carneiro advocated taking a broader view. He noted that the traditional areas were supported by a heavy structure that was not always necessary. He suggested it was now perhaps appropriate to shift resources, and he suggested that the Committee ask itself what was the maximum that could be achieved, rather than always considering the minimum that was needed.

Dr Kaarls agreed in principle, but pointed out that there was no group of scientists meeting specifically to decide such issues. The work undertaken was based on the competence of the CCQM members and the work of the NMIs. He added that the role of the Metre Convention was to establish traceability at the top level.

Dr Hengstberger commented that users look to the CIPM to consider measurements in general, and congratulated the CCQM on what they have achieved. He highlighted the importance of the new work being undertaken



in the area of food analysis, commenting that most areas of chemical measurement were now covered.

Prof. Göbel concluded the discussion with the comment that the CIPM acknowledged the enormous amount of work undertaken by the CCQM. In order to reduce this work load and to ensure the build-up of an effective traceability chain, the CIPM recommended that the CCQM promote the establishment of structures centred at the national and international levels, to provide the link between the work undertaken at NMIs and designated laboratories on the one hand, and at the working level on the other hand.

### 7.3 Consultative Committee for Electricity and Magnetism

Dr Inglis, President of the Consultative Committee for Electricity and Magnetism (CCEM), presented a report to the CIPM on the activities of the CCEM which had met at BIPM on 17 and 18 March 2005, and the meetings of the CCEM working groups.

Recognizing the continuing and important role of the informal RMO TCCEM chairpersons meetings, and mindful of the heavy work-loads on the other WGs, the CCCEM has established a new Working Group for Regional Metrology Coordination (WGRMO), with G. Marullo Reedtz elected inaugural chair. Members of the WGRMO will be representatives of the RMOs, the chairpersons of the WGLF and the GT-RF, the Executive Secretaries of the CCCEM and the JCRB and the BIPM Database Manager.

The CCCEM approved results from the following key comparisons for full equivalence: [CCEM-K9](#) (ac/dc voltage difference at 500 V and 1000 V); [CCEM.M-K1](#) (magnetic flux density); [APMP.EM.BIPM-K11.1](#) (dc voltage 1.018 V, 10 V); [EUROMET.EM.BIPM-K10.a](#) (direct comparison of Josephson standards); [EUROMET.EM.M-K1](#) (magnetic flux density); [CCEM.RF-K8.CL](#) (rf power, 10 MHz to 18 GHz); and [CCEM.RF-K10.CL](#) (rf power, 50 MHz to 26 GHz).

There was considerable discussion, both in the mass community and in the CCCEM, on the possible redefinition of the kilogram. The CCCEM is of the view that “Any decision on the redefinition of the kilogram be deferred until the 2011 CGPM; and that laboratories make their best effort to have data available for the 2010 CODATA adjustment of the fundamental constants to support a possible redefinition in 2011” (see their formal Recommendation E 1 (2005)).

The CCEM monitors the availability of critical devices and notes that while programmable arrays of Josephson junctions and quantum Hall resistance devices are available from a number of sources there is concern over the continued availability of planar multi-junction thermal converters. These have been manufactured by a German organization with government support. If manufacture is to continue, it is likely to move to full cost recovery. The CCEM encourages any initiative that will help maintain their availability and avoid excessive increases in prices.

The CCEM received presentations from members of the BIPM Electricity section on all of the activities of the section, including: work of voltage metrology; impedance metrology; characterization of noise in electrical measurements; the watt balance and the calculable capacitor. In reviewing these activities, the CCEM noted the enormous work load carried by staff in the Electricity section and the very demanding challenges of the watt balance and the calculable capacitor projects.

The CCEM expresses its concern over the staffing situation in the Electricity section, particularly in view of the impending retirements of three senior staff. The CCEM felt it essential that appropriate resources are allocated to enable the watt balance and the calculable capacitor projects to progress at a satisfactory rate and in a timeframe that adds maximum value to international metrology.

The CCEM also addressed the issue of strategic planning and future developments and during the discussion many ideas and emerging fields were suggested as important for electrical metrology.

Dr Inglis drew attention to the CCEM's Recommendation E 1 (2005), on the possible redefinition of the kilogram.

Prof. Göbel thanked Dr Inglis for his report and expressed the Committee's appreciation of the work of the CCEM, and particularly the strategic planning initiative. He commented that over the last few years the CCs have in general suffered from the load of key comparisons. Dr Valdés noted that strategic planning in the fields of acoustics, ultrasound and vibration (AUV) would be incorporated into a report on needs in AUV, which has been updated by the NPL and will soon be published.

Prof. Issaev drew attention to the points involving nanotechnology, and called for collaboration with other CCs in this area.

Dr Carneiro asked whether the needs of the end users had been considered. Dr Inglis replied that the first half-day meeting of the *Ad hoc* Working Group on Strategic Planning had concentrated on the needs of traditional

users such as the electrical power industry. He recognized that other issues, particularly in the nanotechnology, biotechnology and medical areas, were also important and the CCEM did not have contacts in all these areas; they would collaborate with Dr Kaarls and the CCQM to go further in these.

Dr Witt commented that the strategic planning work was at a very preliminary stage. He pointed out that in terms of the Metre Convention, the BIPM deals with NMIs, and of course these NMIs have various commercial customers. The next step would be to develop a questionnaire to distribute to the NMIs.

Dr Luszyk agreed that it was important to get feedback from the stakeholders (the NMIs). On the subject of nanotechnology, he pointed out that there were elements of this in the fields of all CCs, and each CC would have to consider the issues. He believed that good scientific dialogue would suffice, without putting in place any other structures.

Dr Semerjian called for strategic planning to be undertaken at the broadest possible level, starting by identifying the needs of the world around us, and then by defining what the BIPM, CCs and NMIs should do. He called for cross-disciplinary thinking, and suggested that the CIPM address this important issue, perhaps under item 15 of the agenda. Prof. Göbel agreed and welcomed suggestions from the CIPM.

Dr Inglis added that it was important to look more broadly than just the needs of the NMIs. Dr Kaarls commented that the third report on international needs in metrology (the “Kaarls Report II”) would address the issue of the end users. Prof. Wallard commented that the response to this question differed from CC to CC. He drew the Committee’s attention to the EUROMET iMERA initiative (implementing Metrology in the European Research Area), and welcomed the idea of cross-disciplinary strategic planning at the CIPM level.

Prof. Göbel closed the discussion by thanking again the CCEM for their work.

#### **7.4 Consultative Committee for Ionizing Radiation**

Prof. Moscati, President of the Consultative Committee for Ionizing Radiation (CCRI), presented a report to the CIPM on the activities of the CCRI, which had met in May 2005.

The meetings in May were opened with a workshop on dosimetry uncertainties. There were two key-note speakers, Michael Kramer (PTB) on

“Derivation and Propagation of Uncertainties” and Walter Bich (IMGC) on “Uncertainty Evaluation Using a Monte Carlo Method”. The workshop produced a set of 15 recommendations which were sent forward to the CCRI(I) with consequences for all NMIs working in this area. The discussions on dosimetry are important as about 90 % of the NMIs have changed their air kerma standards for photon dosimetry in the last four years.

In activities related to the CCRI(II), significant progress has been made on the development of a method using liquid-scintillation counting to extend the International Reference System for gamma-ray emitting radionuclides (SIR) to cover alpha and beta emitting radionuclides. New procedures have been agreed for submission of samples to the existing SIR and for their inclusion in the key comparison reference values; and a discussion on definitions proposed by the IUPAC resulted in a consensus for the terms activity concentration and specific activity.

In the CCRI(III), discussions on key comparisons took the major part of the meeting. Preparation of final reports for two completed key comparisons on fast neutron fluence rate measurements and the derivations of degrees of equivalence from these data were discussed during the meetings. The status of the on-going key comparison on neutron source emission rate was reviewed and a new key comparison was proposed for thermal neutron measurements, in place of a previous proposal that would have entailed unacceptable delays.

The CCRI now has eleven working groups, one of which is comprised of RMO representatives and reviews the CMC process while the others are distributed across the Sections. Two new working groups were established this year to look at international standards in the specific fields of brachytherapy, and of activity measurements for short-lived radionuclides. Significant progress had been made on a system to categorize radionuclides to enable NMIs to demonstrate their measurement capability while avoiding a heavy workload of participation in key comparisons. This categorization, known as generic groupings, was used as a basis for agreeing a 10-year programme of key comparisons at a reduced frequency relative to previous years.

The CCRI now has 113 CIPM and 18 RMO key comparisons in the KCDB. Not all are yet complete but degrees of equivalence have been published or equivalence approved for 87 % of them.

Analysis of the key comparisons in dosimetry illustrated the need for a recommendation on temporarily extending the period of their validity by 5 years on condition that a new comparison was scheduled. The results from key comparisons were reviewed and once the air kerma standards of the NMIs have been confirmed, which is planned before the end of 2005, this comparison will be published.

The CCRI also discussed the need for other comparisons to support CMCs. For example, two supplementary comparisons led by the EUROMET, but also involving other RMOs as participants, were discussed in the CCRI(III); these involve survey meter calibrations and neutron fluence rate measurements in the range 15.5 MeV to 19 MeV.

The *BIPM Monographie 5* on internationally accepted nuclear data has been published and is also available through the BIPM website. The four earlier BIPM Monographs are also now available to download. A new *BIPM Monographie 6* on source preparation is in preparation as is one on the SIR.

Finally Prof. Moscati presented an informal list of issues in ionizing radiation related to materials metrology.

Prof. Göbel thanked Prof. Moscati for his report, and particularly for the list of issues related to materials metrology, which Dr Bennett will take on board for consideration by the new *Ad hoc* Working Group on Materials (section 11).

## 7.5 Consultative Committee for Mass and related quantities

### 7.5.1 Report of the CCM meeting 2005

Dr Tanaka, President of the Consultative Committee for Mass and related quantities (CCM), presented a report on the activities of the CCM, which held its 9th meeting at the BIPM on 28 and 29 April 2005.

The Working Group on Mass Standards (WGM) reported that comparisons [CCM.M-K1](#), [-K2](#) and [-K3](#) had been completed. A recommendation for the amendment to the equation for air buoyancy correction on mass measurement is presented to the CIPM in 7.5.2 and will be published in *Metrologia*.

The Working Group on Density (WGD) reported that the comparison [CCM.D-K1](#) (silicon sphere) had been completed. The Working Group on High Pressure (WGHP) reported that the comparisons [CCM.P-K1](#) (1 MPa – 7 MPa) and [CCM.P-K7](#) (100 MPa) had been completed, and the Working

Group on Low Pressure (WGLP) reported that the comparison [CCM.P-K4](#) had been completed.

The 4th CCM Pressure Conference was held in London in April 2005, with 104 participants; there were 60 oral presentations, 22 posters and seven exhibiting companies. A special edition of *Metrologia* will be published at the end of 2005 containing about 25 of the presented papers.

The members of the Working Group on Hardness (WGH) discussed a new definition for Rockwell hardness.

The Working Group on the Avogadro Constant (WGA<sub>v</sub>) met in Berlin and heard that the current discrepancy between  $N_A$  and  $h$  is  $1.1 \times 10^{-6}$ . It was hoped that the target uncertainty of  $2 \times 10^{-8}$  would be achieved in 2010.

A workshop on gravimetry was held at the BIPM on 19 September 2005, and this year saw the international comparison of absolute gravimeters (ICAG) at the BIPM.

The recent *Metrologia* paper by Mills *et al.* on the need to redefine the kilogram in terms of a fundamental constant was discussed. One of the authors, Dr Quinn, gave an introduction to the proposed redefinition and asked the CCM how large an uncertainty could be accepted for the purpose of practical mass measurement. The technical difficulties in the watt balance and Avogadro constant experiments show that the level of  $1 \times 10^{-8}$ , once optimistically set in 1991, is unrealistic, although the current discrepancy of  $1 \times 10^{-6}$  between these two routes is still too high.

The CCM had received many position papers from WGA<sub>v</sub>, WGLP, WGM, EUROMET, LNE, METAS, NIST, PTB, against the redefinition and timescale proposed by Mills *et al.* A Recommendation (G 1) on the redefinition, based on the views of the CCM was prepared for the CIPM.

Dr Tanaka announced several new member of CCM WGD (CEM and CENAM) and WGMP (CEM, CENAM and VNIIM). Five new chairpersons were proposed and accepted by the CCM: WGM: Dr Philippe Richard (METAS) in place of Dr M. Gläser (PTB); WGLP: Dr Karl Josten (PTB) in place of Dr A. Müller (NIST); WGFF: Dr Masaki Takamoto (NMIJ) in place of Dr G. Mattingly (NIST); WGMP: Dr Ian Severn (NPL) in place of Dr P. Leggat (NPL); and WGV: Dr Harro Bauer (PTB) in place of Dr R. Kaarls (CIPM, Chair of AHWGV).

It was reported that the Mass section's mercury manometer has been replaced with a piston gauge calibrated at LNE. Proposed work in the section includes the installation and commissioning of a new 8-station

kilogram mass comparator which will provide traceability to weight in vacuum.

In the field of density, the BIPM has a new hydrostatic weighing apparatus developed in collaboration with Dr Spurný (SMU). In the future, the BIPM plans to use 500 g silicon standards to provide traceability and this will allow the use of liquids other than water (e.g. FC40).

In terms of research and development, the BIPM is working on the new mass comparator (in collaboration with Sartorius), air density measurement, mass change between air and vacuum and the International Avogadro Project. Surface adsorption effects have been investigated gravimetrically and by ellipsometry. The measurements showed smaller effects on diamond paste polished surfaces than on diamond-machined surfaces.

Dr Tanaka drew attention to the CCM's Recommendation G 1 (2005), on the conditions required for a new definition of the kilogram.

#### 7.5.2 CIPM-2005 formula for the density of moist air

Dr Tanaka then presented a draft paper by Drs Davis, Fujii and Gläser, and Mr Picard, recommending changes to the constants and uncertainty in the CIPM formula for the density of moist air. The new version of the formula, to be known as the "CIPM-2005 formula for the density of moist air", was requested by the CCM at its meeting in May 2005.

The proposed formula is similar to the CIPM-81/91 formula which it replaces. The main advantages of the proposed CIPM-2005 formula are as follows:

1. correction of what appears to be an error in the assumed value for the amount content of argon in air,  $x_{Ar}$ ;
2. use of the CODATA 2002 recommended value for the molar gas constant  $R$  to replace the value of CODATA 1986;
3. re-evaluation of the uncertainty due to the formula itself, based on the GUM.

The consequences are as follows:

1. Adoption of the new value for  $x_{Ar}$  has the effect of removing a longstanding discrepancy between the value of air density as determined from the CIPM-81/91 formula and the density of the same air sample determined by means of gravimetric analysis using artefacts. Adoption of the new formula will thus make it possible to

recommend the use of a gravimetric technique as a method equivalent to the CIPM formula within their respective uncertainties.

2. Adoption of the new values for  $x_{Ar}$  and  $R$  along with a more searching analysis of all uncertainty components, results in a relative combined standard uncertainty for the proposed CIPM-2005 formula being almost a factor of two smaller than the relative uncertainty assigned by most NMIs to the CIPM-81/91 formula itself.

In answer to a question from Dr Kaarls, Dr Davis confirmed that submission of the proposed article to *Metrologia* was still waiting for publication of the LNE result on the mole fraction of argon in air. He pointed out that there was some urgency to correct the existing CIPM-81/91 formula, and recommended that the CIPM approve the changes in principle. The CIPM duly approved the proposed CIPM-2005 formula for the density of moist air.

### 7.5.3 International Avogadro Coordination (IAC) progress report

Dr Tanaka noted that according to the 2004 meeting of the CIPM, the IAC report should be approved by the CIPM before circulation to the NMIs. He then read out their report.

The IAC is now in its second year of operation. All partners of the IAC have accepted the proposed management structure, and the organization of the IAC with delegates from the NMIs to define the work of pilot laboratories. The IAC members have met regularly and the financing structure has been running smoothly.

The test phase of the  $^{28}\text{Si}$  material production was successfully completed. The enrichment during the whole chain up to the crystal growth was greater than 99.99 %. The overall target uncertainty in  $\Delta N_A/N_A$  is still  $2 \times 10^{-8}$ ; Dr Tanaka presented the current status of the component measurement uncertainties.

In reply to a question from Dr Inglis, Dr Tanaka confirmed that production of the 5 kg Si crystal was on, or ahead of, schedule. Prof. Göbel added that he had visited the laboratory in St Petersburg during the year. The CIPM approved the IAC report and Prof. Göbel thanked Dr Tanaka again for his presentations.



## 7.6 Consultative Committee for Thermometry

In the absence of Prof. Ugur, President of the Consultative Committee for Thermometry (CCT), Prof. Wallard presented a brief report of the 23rd meeting of the CCT, which took place at the BIPM on 9 and 10 June 2005.

The CCT has nine working groups, each of which presented a report to the CCT (more details are available on the BIPM website). The CCT discussed the terms of reference, operational procedures and membership of each working group, the status of CMCs in thermometry, and reports of the key comparisons [CCT-K1](#), [-K5](#), [-K6](#) and [-K7](#).

The two main documents relating to the ITS-90 (the [Techniques for Approximating the International Temperature Scale of 1990](#) and the [Supplementary Information for the International Temperature Scale of 1990](#)) have been made available in electronic form on the BIPM website. Work is under way to update the [Techniques for Approximating the ITS-90](#), and to create a “[Technical Annex](#)” to the [Supplementary Information](#); the latter will form part of a *mise en pratique* for the definition of the kelvin. A draft *Guide on Uncertainty in the SPRT Subranges of ITS-90* is under review, and the CCT granted approval to publish the *Supplementary Information for the PLTS-2000* in the *Journal of Low Temperature Physics*, to enable broad circulation of this information among those most directly affected by the provisional extension to the Scale. Working groups 7 and 8, on key comparisons and CMCs, are successfully using the BIPM Discussion Forum, which was set up at their request.

The CCT also devoted time to various scientific topics, including methods for new determinations of the Boltzmann constant, the possible redefinition of the kelvin in terms of the Boltzmann constant, and specific research work, including gas thermometry and the optical equivalence to dielectric thermometry, the dimensional aspects of acoustic and microwave measurements, the state of Johnson noise thermometry, and the achievable limits of the associated measurement uncertainties. There was general agreement that the return to scientific discussion was most welcome, and that every effort should be made to continue and expand this practice in the future, possibly including the creation of a CCT Workshop to be held in conjunction with the next meeting.

Prof. Wallard drew the Committee’s attention to the three Recommendations approved by the CCT: Recommendation T 1 (2005) on the clarification of the definition of the kelvin, unit of thermodynamic

temperature; Recommendation T 2 (2005) on new determinations of thermodynamic temperature and the Boltzmann constant; and Recommendation T 3 (2005) on the creation of a *mise en pratique* of the definition of the kelvin. He noted that Recommendation T 1 (2005), clarifying the definition of the unit kelvin, had resulted from the results of a CCT key comparison of triple-point cells, piloted by the BIPM ([CCT-K7](#)).

In response to a comment from Dr Carneiro, the word “exactly” was inserted in the line in Recommendation T 1 describing the isotopic composition of water. The CIPM approved all three CCT Recommendations, and adopted T 1 as CIPM Recommendation 2 (CI-2005).

## 7.7 Consultative Committee for Length

Dr Chung, President of the Consultative Committee for Length (CCL), presented a report on the activities of the CCL and its working groups. The CCL held its 12th meeting at the BIPM on 15 and 16 September 2005.

The WGDM had discussed its terms of reference and the processes for the approval of key comparison results. Detailed guidelines were issued for the pilots of the new CCL RMO key comparisons to ensure they fulfilled the requirements of the CIPM MRA, as CCL key comparisons are no longer routinely organized.

The CMC classification scheme, the DimVIM, has been updated and translated into several other languages (Spanish, Finnish, German, Chinese).

Concerning the programme of key comparisons, reports on five comparisons had been approved since the previous CCL meeting, and two new inter-regional comparisons started. The CCL discussed the need to maintain a balance of effort between the various regions.

The CCL produced a number of Recommendations to the CIPM (1a, b, c and d) concerning new or updated values for radiations recommended in the *mise en pratique* of the definition of the metre. They also recommended combining this list of recommended radiations with the CCTF list of radiations recommended for the secondary representation of the second, and merging the CCL MePWG with the Joint Working Group CCL/CCTF on Secondary Representations of the Second. Draft terms of reference were drawn up for the proposed new group, to be called the Joint Working Group of the CCL/CCTF on Reference Frequencies. The suggestion was formalized in CCL Recommendation 2 (2005).

The CCL also discussed the future work of the Length section at the BIPM. This subject is treated in section 14.2 below.

Prof. Göbel thanked Dr Chung for his report and invited discussion.

Dr Arias pointed out that CCL Recommendation 2 (2005), to merge the CCL MePWG and the Joint Working Group CCL/CCTF, also required the agreement of the CCTF. The CIPM welcomed the recommendation to merge the two groups, subject to the approval of the CCTF.

Dr Semerjian questioned the CCL decision to carry out RMO key comparisons, rather than CIPM key comparisons. Dr Quinn explained that this dated back to discussions of the WGDM in 2002, and unfortunately the CCL WGDM (and the CCT) had not accepted the CIPM MRA Guidelines. However, Dr Quinn believed that the practice would die out and recommended that the CIPM took no further action. He reiterated that CIPM key comparisons are intended to be comparisons of principal techniques, not practical realizations of units.

Dr Kaarls commented that the CCL carried out too many key comparisons, in an attempt to underpin all the CMCs. Dr Inglis added that there was perhaps a problem of terminology. If comparisons are not interconnected, then they should be called supplementary, rather than key.

Prof. Göbel thanked Dr Chung and asked him to transmit the concerns of the CIPM to the WGDM.

## **7.8 Consultative Committees rules and policy**

Dr Kaarls presented a document on general rules and policy of the CIPM Consultative Committees. This document clarifies the generic organization and rules under which the Consultative Committees should operate. It gives guidance on the work of the CCs and how they may work with other organizations which have interest in the relevant field of metrology or which represent a specific user community or other specialist group.

Dr Semerjian asked whether the possibility of setting fixed terms for the Presidency had been considered. Dr Quinn commented that in fact it was hard to find CC Presidents that stayed long enough to ensure continuity.

Dr Carneiro noted that reports from over seventy bodies (Joint Committees, Consultative Committees and working groups) had been presented to the CIPM, and commented that this seemed a rather heavy structure.

The CIPM approved the document and requested that the CC Presidents draw it to the attention of their members, and that each Consultative

Committee works on developing its own strategy and work plan to reflect their own technical priorities.

### 7.9 CC Membership

The CIPM approved the application of the CEM, currently Observer of the CCM, for full membership of the CCM. A request from INMETRO for observership of the CCT was agreed subject to the approval (duly received) of Prof. Ugur.

### 7.10 Future meetings

The following dates were confirmed for future meetings of the Consultative Committees, CIPM and other meetings at the BIPM:

#### 2006

CCQM	6–7 April
CCQM WGs	3–5 April
CCL-CCTF	13 September
CCTF	14–15 September
CCAUV	25–26 September
CCAUV RMOWG	27 September
CIPM	10–13 October

#### 2007

CCEM	15–16 March
CCEM WGs	12–14 March
CCQM	April (dates to be confirmed)
CCRI	31 May (starting at 2 pm)
CCRI(I)	14–16 May
CCRI(II)	23–25 May
CCRI(III)	29–31 May (finishing at 1 pm)
CCU	11–13 June
CCPR	21–22 June
CCPR WGs	18–20 June

CCL	13–14 September
CCL WGs	10–12 September
CIPM	9–12 October
CGPM (provisionally)	15–19 October

Prof. Göbel concluded the item by thanking all the Executive Secretaries for their work.

## **8 JOINT COMMITTEE FOR TRACEABILITY IN LABORATORY MEDICINE**

Dr Wielgosz, Executive Secretary of the Joint Committee for Traceability in Laboratory Medicine (JCTLM), reported on the activities of the Committee.

The JCTLM has continued its programme of establishing databases of higher order reference measurement procedures and reference materials, as well as reference measurement services provided by laboratories. Meetings of the Executive of the Joint Committee were organized in December 2004 and July 2005, and the JCTLM working groups met in July and September 2005. A meeting of JCTLM members and stakeholders was held at the BIPM in December 2004, together with a symposium on reference measurement systems for biologicals.

The Committee's membership has risen to twenty organizations, in addition to the three sponsoring organizations (BIPM, IFCC and ILAC). The secretariat is being funded jointly by the IFCC and the BIPM. The work of the Committee has been presented to the Medical Devices Expert Group of the European Commission's DG Enterprise, and liaison with the EC is continuing.

The JCTLM database of higher order reference materials and reference measurement procedures was updated in January 2005, and presently contains 159 entries for reference materials, and 97 entries for reference measurement procedures. The review teams of JCTLM Working Group 1, covering thirteen different analyte categories, have continued the review process for the second cycle of nominations of reference materials and

procedures, and this will be completed in November 2005. The procedures used for the nomination and review of materials and methods are publicly available via the BIPM website, and updated procedures that are to be implemented for subsequent review cycles will be published at the end of the year. The BIPM is currently converting the JCTLM database to a web-searchable format, and this will be completed in early 2006.

JCTLM Working Group 2, on Reference Laboratory Networks, have been developing procedures for reviewing and publishing reference measurement services provided by reference laboratories. The listing of a measurement service in the JCTLM database will be based on that service fulfilling specific criteria, notably:

- a) that the measurement service is a realization of a reference measurement procedure published in the JCTLM database;
- b) that the laboratory has been accredited for this service or that this service is peer-reviewed through the CIPM MRA process; and
- c) that the laboratory demonstrates that it maintains this service within its specifications through regular participation in international comparisons.

Laboratories active in the CIPM MRA process, and delivering reference measurement services in laboratory medicine described by published calibration and measurement capabilities within the Appendix C, can nominate these services for entry into the JCTLM database. Provided these services are realizations of one or more of the reference measurement procedures published in the JCTLM database, the measurement services can be published in the database without further review. This will enable the JCTLM database to provide a comprehensive list of reference measurement services provided by laboratories in the field of laboratory medicine.

Prof. Göbel thanked Dr Wielgosz for his report and asked if access statistics were available for the JCTLM database. Dr Wielgosz replied that an in-depth study would be carried out when the new database is on-line; the targeted user group is the *in vitro* diagnostic industry.

**9 REPORT FROM THE MEETING OF NMI DIRECTORS 2005**

Prof. Wallard reported that there had been nearly 100 participants at the meeting of NMI directors of Member States held at the BIPM on 29 and 30 September 2005. For the first time, directors of NMIs of Associates of the CGPM had also been invited to attend. He reminded the CIPM that the first few such meetings had been concerned with the preparation and launch of the CIPM MRA, and reports from the JCRB. This year's meeting had focussed more on strategic topics, and he had briefed the directors on the planning for the next CGPM and the BIPM's work programme. The bureau of the CIPM now sought feedback on the frequency and timing of such meetings, and the subjects that should be addressed.

Dr Tanaka commented that he had found the discussions interesting and suggested that the directors should be asked for feedback. Prof. Wallard said he welcomed all feedback but noted that questionnaires typically attracted few responses.

Dr Hengstberger noted that many directors are not directly involved in the CIPM or JCRB, and that the meeting provided a useful opportunity to keep them informed about the CIPM MRA. Dr Kaarls added that they also provided a useful occasion for directors to meet each other, and agreed that it was important to consider the flow of information to directors, and from NMI directors to directors of Designated Institutes.

Dr Semerjian said that scheduling the CIPM and Directors' Meetings together posed a problem. He would prefer them to be scheduled either apart, or within a single week.

There was general agreement that the meetings were useful and should continue, on a more or less regular basis but not necessarily every year. Prof. Göbel said that all comments were welcome, and the bureau would give consideration to future timing and what to do during the year of a General Conference.

## 10 METRE CONVENTION/ILAC JOINT WORKING GROUP

Prof. Wallard commented that there was a good atmosphere in the Metre Convention/ILAC Joint Working Group, which was made up of senior representatives of ILAC and the BIPM. He presented for final approval by the Committee a joint statement produced by the CIPM and the ILAC on the roles and responsibilities of national metrology institutes and national accreditation bodies. This statement, entitled “Improving worldwide traceability and acceptance of measurements carried out within the CIPM MRA and the ILAC Arrangement”, had already been approved by ILAC. The next step, he said, would be for ILAC and the CIPM to promote the agreed document to the wider community.

The document was approved by the CIPM after discussion of various issues, primary among which was the future of the relation between the CIPM and ILAC. Dr Semerjian considered that in general there was too much emphasis on accreditation of NMIs, saying that this was only one way of demonstrating conformity with the quality regulations of the CIPM MRA. Dr Schwitz agreed that satisfying all the conditions for participation in the CIPM MRA was in itself a means of demonstrating competence. Prof. Wallard noted that ILAC had taken on board concerns expressed about the quality of assessors used at the national level.

Dr Inglis suggested that NMI accreditation should be considered as formalized peer review, and noted that in the APMP, accreditation was generally sought where it would add value. There was general agreement, however, that while working together with ILAC was useful, it did not automatically follow that there were common interests in all matters. The group carrying out the formalized peer review should strengthen, not threaten, the system.

Prof. Issaev asked whether understanding had been reached on the term “best measurement capability” (BMC). Prof. Wallard acknowledged that the CIPM MRA explains the term CMCs, although regulators tend to refer to BMCs. He confirmed that the subject was under discussion by the JCRB, but no changes had yet been adopted.

Dr Valdés asked how ILAC would deal with NMI calibration certificates not supported by CMCs. Prof. Wallard explained that, in order for an NMI calibration certificate to be accepted by other NMIs within the CIPM MRA,



traceability to the SI should always be established through an NMI with a CMC published in the KCDB. This applied to the NMI issuing the certificate, or to the NMI to which the issuing NMI was traceable. In the case where no CMCs are published, the question of how to convince the accreditors remains, as it has always been, a national issue.

Dr Hengstberger noted that accreditors now appreciated that NMIs were not normal calibration laboratories, and suggested that ILAC should produce special documents for NMIs, as they had done for other special laboratories. He also called for the interval between re-assessments to be lengthened. Dr Kaarls agreed that assessment of an NMI often required much more information than just compliance with ISO 17025.

Mr Énard asked what were the next projects for the Joint Working Group. Prof. Wallard said that a document would be produced to address the various points that had been raised.

## 11 MATERIALS METROLOGY AND THE METRE CONVENTION

Dr Bennett presented document CIPM/2006-16: Report to the CIPM on Metrology for Materials.

It was agreed at the 93rd meeting of the CIPM that Prof. Wallard, in collaboration with Dr Bennett, would respond to the letters from the Chairmen of ANMET and VAMAS, requesting further details about the perceived needs in the field of metrology for materials, and that Prof. Wallard would also ask the Consultative Committees to define their activities and interests in the area. There has been little response from the Consultative Committees, but the request to ANMET and VAMAS resulted in a workshop being held at the BIPM on 28 February 2005.

This workshop was attended by representatives from BAM, CENAM, INMETRO, KRISS, LNE, NMIJ, NPL and the BIPM. Following a number of presentations, discussion centred on the metrology and traceability issues raised by materials testing. A draft remit for a Joint Committee on Traceability in Materials Metrology was considered, based on the remit of the JCTLM. It was recommended that further contact be made with national

accreditation bodies, as well as with ILAC, who will have direct experience of the traceability issues through accreditation of test laboratories.

The meeting considered six possible courses of action:

- the formation of a Consultative Committee of the CIPM;
- the formation of a Joint Committee for Traceability in Materials Metrology;
- the inclusion of more materials activities in current CCs;
- the formation of a CIPM working group;
- the encouragement of ANMET and VAMAS to redirect their activities;
- a decision to do nothing.

Arguments for and against these options were discussed. The clear majority view was that the CIPM should once again be requested to initiate action to provide international leadership in metrology for materials. There was widespread agreement that a new Consultative Committee would not be appropriate in the absence of an identified work programme. While some of the known issues fall within the scope of existing CCs, this is not completely the case and there is no single CC which could undertake the sort of broad study required. In the event that CIPM decides that there is no need for activity under its auspices, VAMAS has already considered the possibility of taking a further initiative itself by seeking to extend its membership in order to obtain wider international agreement on the solutions required.

The meeting confirmed the earlier recommendation that the CIPM should create a working group to undertake an initial study of some clearly defined areas where there are significant metrology issues surrounding the variability of published measurement results and the associated regulatory requirements.

Dr Bennett concluded his report with the recommendation that the CIPM set up a temporary working group for a period of two or three years under the chairmanship of a CIPM member. He proposed the following draft terms of reference:

- to identify the need for traceable measurements in the field of metrology for materials not currently covered by the Consultative Committees;
- to identify opportunities and mechanisms for working with Consultative Committees in areas of common interest;

- to establish, in the first instance, the user needs for activity in materials metrology;
- to define the specific objectives, initial activities, and long-term aims for an ongoing programme in metrology for materials;
- to establish a methodology for traceability in materials testing;
- to recommend activities required to underpin this methodology, such as the organization of key comparisons and the development of appropriate reference materials;
- to undertake or initiate pilot exercises where these can be completed within the period of operation of the working group;
- to liaise closely with other interested organizations;
- to report its conclusions to the CIPM.

Prof. Göbel thanked Dr Bennett for his report and invited comments.

There was wide support for the suggested formation of an *Ad hoc* CIPM Working Group on Materials Metrology, and the CIPM approved the creation of such a group, to run for two years (until the next CGPM) under the chairmanship of Dr Bennett. Dr Tanaka and Dr Chung were encouraged to participate.

It was clear that materials metrology was of great interest to many NMIs, and Dr Carneiro expressed his support for the future creation of a Joint Committee on Traceability in Materials Metrology. He suggested that the terms of reference of the *ad hoc* working group should include the making of a recommendation on the future management of materials metrology.

Mr Érard, Prof. Göbel, and Dr Semerjian expressed reservations about including testing within the remit of the working group, as this was largely the responsibility of other bodies. Dr Semerjian suggested that the membership should include a testing organization, such as the American Society for Testing and Materials (ASTM), so that the various issues concerning responsibility could be shared out appropriately. He supported Dr Carneiro's comments in favour of a Joint Committee.

Dr Bennett noted the CIPM's request to concentrate on issues of traceability, and agreed to circulate the draft terms of reference, and suggestions for membership, to the CIPM for comments before the first meeting of the *ad hoc* working group.

## 12 CONTACTS WITH OTHER INTERNATIONAL ORGANIZATIONS

The BIPM/CIPM's relations with ILAC were covered under agenda item 10. Prof. Wallard gave a brief resume of the numerous other interactions between the BIPM and international organizations:

**WMO:** As mentioned under point 5.5, discussions are under way on the possibility of the WMO signing the CIPM MRA. The possibility of organizing a joint conference on metrology and climate change was discussed previously, and this might be a useful means of working more closer together, as well as a means of raising the profile of the BIPM in that area.

**OIML:** Relations with OIML continue to be productive, as discussed under item 4.1; Prof. Wallard remains in close contact with Dr Magaña, Director of the BIML.

**WHO:** There has been much progress in the last year in terms of the WHO's attitude to traceability and uncertainty. There remains some legal difficulty in their formal association with the JCTLM, but high-level contacts are maintained, particularly through Dr Wielgosz.

**WTO:** There has been no progress with the BIPM's efforts to obtain Observer status on the WTO TBT Committee. CIPM members and directors who might have influence on TBT members are encouraged to make contact with them to try to unblock the political stymie.

**ISO/IEC:** Prof. Wallard noted Dr Inglis' comments on the importance of the IEC and ITU in the field of electricity and magnetism. The BIPM's liaison person to ISO is Dr Köhler; in particular the BIPM has Liaison A status with ISO TC 12, ISO TC 176, ISO REMCO and ISO CASCO. There is also some collaboration through the working groups of the JCGM.

**CODEX:** The BIPM has Observer status at meetings of the Codex Alimentarius Commission. It is not yet clear how far this area of work will expand.

**CIE:** A Memorandum of Understanding is being drawn up in collaboration with Dr Hengstberger and Dr Stock. Areas of common interest will be discussed during the CCPR meeting on 25-26 October 2005.

The CIPM commended Prof. Wallard on these interactions, noting that it was an important area of work for the BIPM, and widely appreciated.

Dr Semerjian noted that this was an area in which the BIPM could make a unique contribution. He suggested that the BIPM should also try to take advantage of the technical expertise of NMIs to help with interactions at the technical level.

Dr Schwitz asked what would happen if the WMO became a signatory of the CIPM MRA, in that the PMOD-WRC is already a Designated Institute named by METAS, with CMCs published in the KCDB. Prof. Wallard replied that it was too early to say; the WMO has many technical centres and this issue would have to be considered carefully.

Dr Semerjian welcomed the idea of holding a workshop or other joint event with the WMO, particularly in light of the political importance of issues such as climatic change. He suggested that attention should be drawn to the results of CCQM key comparisons of measurements of methane, where a bias was apparent between results reported by NMIs and WMO laboratories. Dr Kaarls noted that there was increasing interaction between the WMO and the CCQM Working Group on Gas Analysis. He and Dr Quinn added their support to the idea of holding a conference on metrology in climate change, which would help raise the political profile of the BIPM. Prof. Issaev agreed to continue discussions with Prof. Wallard on this subject.

Dr Hengstberger remarked that the WMO were more interested in relative changes than in absolute measurements, pointing out that they had a world-wide network referring to a single point, even if that were not SI-traceable. A link should be established between the WMO scale and that of the NMIs. A brief discussion ensued on the importance of absolute measurements, particularly for long-term measurements.

Prof. Issaev noted the importance also of increasing contact with the IEC, and called for a joint statement to be drawn up with the OIML that would establish clearly the roles of the two organizations, and identify possible joint projects. Dr Kaarls considered that it was for scientists to do the science that underpinned legislation, not to produce legislation themselves. But Prof. Issaev pointed out that if we say “they do law, we do science”, then who is responsible for the total measurement system?

Prof. Göbel noted the comments on the OIML, and concluded the discussion.

## 13 JOINT COMMITTEE FOR GUIDES ON METROLOGY

Dr Michotte and Mr Delahaye, BIPM contact persons of the JCGM working groups 1 and 2, respectively, joined the CIPM for Prof. Wallard's presentation.

Prof. Wallard reminded the Committee that the JCGM's tasks are: to promote the use of the *Guide to the Expression of Uncertainty in Measurement* (GUM); to prepare supplementary guides for its broad application; and to revise and promote the use of the *International Vocabulary of Basic and General Terms in Metrology* (VIM). The JCGM took over responsibility for these two documents from ISO TAG 4, who originally published them under the auspices of the Committee's collaborating bodies BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML. The Chairman of the JCGM is the Director of the BIPM and the Chairs of the two working groups are Dr Walter Bich (IMGC) and Prof. Pierre Giacomo (BIPM).

Both groups meet regularly and are working, respectively, on supplements to the GUM and a revision of the VIM. Current expectations are that their work will be complete by the end of this year and that publication of the documents will be in 2006. The means of publication have been discussed with both groups and a number of the sponsoring bodies.

During the course of Prof. Wallard's discussions with the sponsoring bodies, ISO claimed they had no record of their formal endorsement of the JCGM's founding document, the "Charter". *Inter alia*, this Charter gives to each of the sponsoring bodies the right to publish the jointly produced documents in whatever form meets their organization's needs. Current WG members support a web-based facility that provides the documents without charge. However, ISO has traditionally published the documents in hard copy on behalf of the sponsoring organizations, and makes a charge for them.

In order to settle the issue of the Charter and to find a common agreement on the form of production, Prof. Wallard has called a meeting of the JCGM itself – the first for many years. At this meeting, scheduled for 30 November 2005, the sponsoring bodies will review the operations of the working groups, and discuss possible rotation of the chairmanship and secretariat; if the BIPM is to continue in these roles then possible contributions to financing the JCGM will be discussed.

The CIPM strongly supported making the GUM Supplements and the VIM available free of charge on the web. Prof. Moscati suggested that the JCGM should also evaluate what minimum changes may be necessary to update the GUM and also publish an electronic version. Dr Quinn agreed that it was important that the BIPM made every effort to ensure that the new edition of the VIM would be distributed widely and without charge. He suggested that legal advice should be sought as to what would happen if we published the GUM on the web.

Dr Hengstberger commented that it was currently difficult to get hold of printed copies of the JCGM documents, particularly in developing countries.

Prof. Wallard pointed out that the JCGM Charter committed ISO to sharing the work of the VIM, but added that ISO had also produced their own vocabulary. Prof. Issaev noted that the OIML had also produced their own vocabulary – the VIML – with the input of legal metrologists but without the participation of ISO. He suggested that the BIPM and OIML combine their efforts to form a metrological vocabulary. Dr Inglis cautioned that competition between different vocabularies would be unproductive. Dr Schwitz concurred that it was beneficial to have the support of ISO; and Prof. Wallard and Prof. Göbel agreed that it was in the general interest for ISO to endorse the VIM and use it in their standards.

Prof. Göbel concluded the discussions by thanking Dr Michotte and Mr Delahaye for their work.

## **14 WORK OF THE BIPM**

### **14.1 Director's Report**

Prof. Wallard presented the Director's Report, which as per usual had been circulated to the CIPM members prior to the meeting, in the following terms:

Last year I reported to you on a number of significant events for the BIPM, notably the outcome of the 2003 General Conference on Weights and Measures and the progress made in implementing the CIPM MRA. During the last year, we have begun the four-year work programme which was

approved by the General Conference and have taken steps to develop long-term plans for the BIPM. In addition, we have completed the transition period for the CIPM MRA, have extended our activities in the chemical sector and have consolidated and extended our collaborations with a number of international bodies.

The BIPM is currently in good financial and scientific shape, but we are facing current and future resource limitations. As far as possible, and within the financial and other constraints imposed by the 2005-2008 work programme, we are increasing, and must continue to increase, our resources devoted to the scientific and other needs of new areas of investigation. Many of these needs were not evident when the CGPM approved our work programme in 2003 and we have made regular reports to the CIPM on how we are adapting the work programme to respond to the most urgent priorities. We do, however, appear to be victims of our own success in many of the initiatives we have taken in chemical metrology. We therefore need to be careful that we do not overstretch our resources and lead to unrealistic expectations of our ability to deliver solutions to all the needs and requirements of these communities. Although there has been a substantial shift of resources away from physics at the BIPM in the last few years, we must continue to balance the newer activities against the well-established and continuing needs of Member States and Associates. This is not an easy task. We are, however, grateful that a number of NMIs are prepared to lend, or second staff to us in accordance with Resolution 12 of the last General Conference. This will, I am sure, be a subject that will continue to exercise the minds of staff here, as well as those of the members of the CIPM.

BIPM's Photometry and Radiometry section finally closed its doors in the summer of 2004 after some 70 years of activity at the BIPM. The previous members of this team are now working with colleagues in the Electricity section to start up new projects on the watt balance and the calculable capacitor in collaboration with our Australian and Canadian colleagues.

There have been substantial successes in other scientific sections. In the Ionizing Radiation section, a large number of comparison reports have been published despite a heavy programme of comparisons and the updating of the SIR electronics, the replacement of the medium energy x-ray tube and improvements in the mountings for the cobalt source. The Mass section has made measurements on a silicon sphere as part of the international Avogadro project and there have been a number of important publications



about the FB2 balance, and on air density. Individuals from the Mass and Chemistry sections produced one of the BIPM's most highly cited papers on the composition of air. The Length section published another of the year's most important papers on the performance of frequency combs in *Science*, and the Time section has revised and automated the production and dissemination of TAI and UTC. They have also tackled the difficult subject of uncertainty in UTC and have maintained a successful series of comparisons of GPS receivers. Details of other progress and achievements are, as usual, summarised below and then expanded in the reports from individual sections.

**Length:** In laser absolute frequency measurements, this year has largely been one of consolidation after the launch of the femtosecond comb-based key comparison [BIPM.L-K11](#) which replaced the previous heterodyne measurements and the advances in validation of comb performance at the  $10^{-19}$  level. The comb technique is now used routinely in the calibration of lasers from NMIs and, of course, in [BIPM.L-K11](#). We are steadily improving the performance of our comparison and calibration capabilities, simplifying systems and ensuring a reliable and effective electronic measuring system.

A number of small improvements are in hand aimed at system reliability and a more compact comb system which can be used outside the BIPM in comparisons and regional measurements where needed.

The use of direct absolute frequency measurement techniques on the lasers calibrated at BIPM using our combs means that we do not need to make estimates, as in the past, of uncertainties due to iodine cell impurities as any such shift is measured by the comb system. As a result, we can give lower uncertainties for our measurements. This has meant that there is an improvement in the way in which the metre can be realized using such systems.

Other laser work is aimed at maintaining our current competences and at a comb-based measurement of the methane stabilized laser frequency. The inherent difficulties in operating complex infra-red laser systems are still causing problems, and progress on the project will be critically reviewed later this year.

In dimensional metrology, the compact diode-pumped laser systems are showing excellent performance characteristics as sources for interferometry. Our current plans are for these to be used in the calculable

capacitor and watt balance projects and in a redesigned and more reliable absolute gravimeter.

In the past year, we have devoted more effort to gravimetry, improving local reference systems and measurement systems in preparation for the next international comparison of gravimeters. The absolute gravimeter belonging to the BIPM will perform the gravity field monitoring during the comparison and several measurements of the links of the gravity network of the BIPM which should provide an additional assessment of the performance of the several similar commercial systems we expect to take part in the comparison.

Finally, the decision to create a joint working group between the CCL and the CCTF to deal with potential secondary representations of the second has proven to be a wise decision in the light of recent advances in optical laser frequency standards. The opportunity to validate the performance claims of these new sources through the assessment processes of the joint group has stimulated considerable interest amongst this community and is a further step towards the possibility of an “optical” second. At the moment, though, there needs to be considerable improvement in the performance of remote comparison techniques in order to take advantage of the performance of optical clocks for the international time scale.

**Mass:** Calibration certificates have been issued for seven 1 kg prototypes. Six of these prototypes were newly manufactured, as described in the 2004 Report. In addition, eight 1 kg standards in stainless steel were calibrated at the request of NMIs. Three of these were new and required a volume determination. At this time, a serious, though subtle, problem was identified within the calibration laboratory, causing a major disruption to our service. Although no calibration results were compromised, our normal work was suspended for several months until the problem could be studied and resolved. Steps have been taken to re-establish confidence in our measurements once the problem had been resolved. Part of the work that had been postponed during this episode was the periodic re-calibration of the BIPM working standards with respect to 1 kg prototype No. 25, which we reserve for exceptional use. The re-calibration is now nearing completion.

The CCM met in April 2005. Work of the BIPM Mass section has contributed to CCM in several ways: a paper on the amount content of atmospheric argon appeared in *Metrologia* and has been downloaded more than 500 times. This work is based on new measurements, made by KRISS,

as well as a critical re-evaluation of all available data, made by the Mass section and Chemistry section of the BIPM. A companion *Metrologia* paper, written in collaboration with the PTB, describing direct determinations of ambient air density has been downloaded more than 200 times. The CCM decided that these papers form the technical basis for a future revision to the CIPM-81/91 equation-of-state for moist air. This work has already been useful for carrying out mass determinations of 1 kg spheres of single-crystal silicon. This is done as part of our participation in the International Avogadro Coordination/CCM Working Group on the Avogadro Constant (IAC/CCM-WGAv). Additional work has been carried out on mass changes between atmosphere and *vacuum* due to physisorption and desorption. Techniques developed in this area for the IAC/CCM-WGAv are also applicable to watt balance experiments.

Considerable progress has been made in re-establishing an internal calibration service for pressure measurements near one atmosphere. This work was necessitated by the failure of the BIPM mercury manobrometer and its replacement by a high-quality pressure balance.

**Time:** From January 2005, the uncertainties of  $[UTC - UTC(k)]$  are also published in the *Circular T*, in coincidence with the first publication of the key comparison in time [CCTF-K2001.UTC](#) in the KCDB. The results of this key comparison are updated monthly after the publication of *Circular T*. The medium-term stability of TAI, expressed in terms of an Allan deviation, is estimated to be about  $0.4 \times 10^{-15}$  for averaging times of one month. The accuracy of TAI is based on the data from eight primary frequency standards that include, at present, four caesium fountains (IEN CSF1, LNE-SYRTE FO2, NIST-F1, and NPL CSF). Following the recommendation of the CCTF, a monthly correction of order  $0.7 \times 10^{-15}$  is applied to steer the frequency of TAI. Since July 2004, the scale unit of TAI has been estimated to match the SI second to within  $2 \times 10^{-15}$ .

An important part of the activity of the Time section deals with studies of time and frequency comparison using global navigation satellite systems. Common-views of GPS satellites with single and dual frequency receivers and TWSTFT links are routinely used in the calculation of TAI. The incorporation of dual-frequency geodetic type receivers and the TWSTFT observations on a sub-daily scheduled have brought the uncertainty of some time links down to the nanosecond level or less. Calibration programmes of GPS receivers have been organized and run by the section, with more than 50 % of the receivers participating to TAI calibrated.

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 and the USNO jointly provide the Conventions Product Centre of the International Earth Rotation and Reference Systems Service (IERS) with the responsibility of establishing conventions for space-time reference systems; the *IERS Conventions* (2003) have been published and updates are performed on the Conventions website which is maintained at the BIPM. The Time section's other research subjects involve pulsars, future clocks in space and atom interferometry.

**Electricity:** A high-priority item in this year's activities in the Electricity section is the training of the new members of the section (transferred from the Photometry and Radiometry section) in the activities of voltage and impedance metrology. One of the new members is already able to carry out measurements using the BIPM Josephson voltage standard and qualified, in the sense of our Quality System, to use Josephson standards to calibrate other voltage standards. A second staff member is learning to operate the BIPM quantum Hall effect standard and is already qualified to calibrate capacitance standards. As a follow-up to the enthusiastic response to last year's questionnaire on participation in further BIPM on-site comparisons of Josephson standards in which 33 of the 35 specialists polled said they want to participate, we have carried out new comparisons with the NPL and the NRC and have scheduled four more comparisons for 2005. At the same time, work is progressing on two projects: the development of a completely automated facility for calibrating 1.018 V voltage standards and the development of a compact, more easily transported Josephson standard. Through our participation in the key comparison [EUROMET.EM.BIPM-K10.a](#), the comparison results were linked to the BIPM Josephson standard which served as the key comparison reference value. In the area of resistance metrology, we have significantly improved the sensitivity of our cryogenic current comparator bridge by replacing the old rf SQUID with a dc SQUID. In the domain of capacitance metrology, we have successfully made delicate modifications of four of our fused silica capacitors to reduce leakage capacitances to negligible levels and we have finished construction of the equipment for accurately measuring the capacitance of a 1 pF standard with respect to the forthcoming BIPM calculable capacitor. The work on the characterization of noise of polarity-reversed dc voltage measurements is completed and has been published. In addition to demonstrating that polarity reversals of a voltage source featuring a high level of  $1/f$  noise do not remove this type of noise, we demonstrated that the

noise model for Zener voltage standards must contain a surprisingly high level of white noise as well as  $1/f$  noise. Our joint project with the NIST on the characterization of noise in precision dc voltage measurements was successfully concluded and the results published. This work triples the number of Zener standards for which the noise processes are now well-characterized. An adjunct to this work was the study of the quantization noise due to the finite resolution of digital voltmeters; from our analysis of voltage measurements, the Allan deviations often decrease below the values predicted by the usual simple noise quantization models. In the general area of time-series analysis, we are working with the Chemistry section on the application of Allan variance and autocorrelation function methods to characterize molar concentration measurements and on the characterization and experimental design of several measurement routines used in the BIPM measurements of the Newtonian gravitational constant. Some Electricity section staff continue to engage in thermometry activities on a part-time basis. In its role as pilot laboratory for the key comparison of water triple point cells, [CCT-K7](#), the BIPM has identified a statistically-significant difference between the results of participants who applied corrections for the isotopic composition of the water in their triple point cells and those who did not. This has led the CCT to recommend an improved definition of the kelvin by adding a statement about the isotopic composition of the water in triple point cells. To lighten the work load associated with calibrations of thermometers for the other BIPM sections, it was decided to restrict BIPM calibrations to those of platinum resistance thermometers used near room temperature and for which high accuracy is necessary; other thermometer calibrations are now outsourced.

*Calculable capacitor:* The BIPM workshop is continuing the fabrication of components for the two calculable capacitors being developed in this cooperative project with the NMIA. As part of this work, a complex parallel motion spring was manufactured, making use of electro-erosion techniques. The device to measure the straightness of the electrode bars, the parts of which were made during the previous reporting period, has been assembled and automated at the NMIA and is now in regular use. The NRC has recently signed a bilateral contract with the NMIA to obtain the critical components of the capacitor, of which we will also provide a number. Significant progress has been made on the capacitance bridge for the calibration of 1 pF capacitance standards against the calculable capacitor. All elements have been constructed and it has been shown that the divider ratios can be calibrated to 1 part in  $10^9$ . A prototype of the laser to be used

for the interferometer has been modified according to the requirements of this application. We are currently preparing an experimental test of the design of the Fabry-Perot interferometer which is proposed by our colleagues at NMIA.

*Watt balance:* During the last year we have further developed our plans for a watt balance which allows for simultaneous weighing and the moving mode operation, and have started to assemble the first components of the room-temperature model. We have pursued our idea of a highly symmetric and closed magnetic circuit in collaboration with a consulting company. The finite-element calculations of the magnetic flux distribution made at the BIPM have been confirmed. The geometry initially proposed by us was optimized to obtain a much better uniformity of the magnetic field in the air gap. No fundamental difficulties with this form of the magnetic circuit were identified. In parallel to this work, which should result in the availability of a high-quality magnet at the BIPM in 2006, we have started to build a simplified magnet with the BIPM workshop to test some of the other components as soon as possible. The functioning of an electrostatic motor for moving the coil through the magnetic field was studied by a numerical simulation. A balance suspension including such a motor has been fabricated. The suspension includes several flexure strips to avoid friction. A constant current source used previously for the calibration of Zener voltage standards was modified and now delivers a current of 1 mA with a stability of about 1 part in  $10^7$ , sufficient to provide the current for the travelling coil of the room temperature model.

**Ionizing Radiation:** We have completed the experimental determinations and Monte Carlo calculations of correction factors for the  $^{60}\text{Co}$  beams and a paper on the new BIPM air kerma determination will be submitted for peer review publication. This new determination was discussed during a Workshop on Dosimetry Uncertainties which was attended by 25 external experts from 18 NMIs that the BIPM organized in May 2005. The CCRI has agreed in principle to the changes and these are likely to take place in 2007. The Compton x-ray spectrometry comparisons, involving experiments and Monte Carlo calculation are progressing satisfactorily with some anomalies to resolve at lower energies before the mammography spectra for dosimetry comparisons are confirmed. The accurate measurement of specific heat capacity has been automated and the system is being used for graphite and sapphire test samples prior to the design and construction of the prototype graphite calorimeter standard for absorbed dose. Following the analysis of the comparisons of present standards for

absorbed dose, the results for eleven NMIs are now published in the KCDB. Three new dosimetry comparisons have been made and 17 national secondary standards have been calibrated. A successful internal audit was made of the Quality System for calibrations.

Eighteen laboratories participated in a workshop on activity key comparisons that we held in November 2004. The seven most recent comparisons were discussed and the resulting recommendations on activity measurements were presented to the CCRI in May 2005. Two other key comparisons have been completed recently, the  $^{125}\text{I}$  comparison draft A report is circulating and the  $^{32}\text{P}$  results are due to arrive shortly. The BIPM radionuclide measurement facilities, particularly the electronics, have been updated and the balance facilities improved to cope with this increased workload. The CCRI has agreed to group radionuclides by category to reduce the number of CCRI(II) key comparisons from three to about one per year for the next ten years. This together with NMI participation in the BIPM ongoing activity comparisons using the SIR enables coverage of all the radionuclides in CMCs. In addition to several CCRI(II) comparison ampoules, nine laboratories have submitted twelve different radionuclides to the SIR this year. In the last twelve months, a further twelve SIR comparison reports have been published. We have now published all pre-2004 results while the results from 2004 have been analysed and are circulating in draft A or B reports. Impurity activity levels were measured using the BIPM Ge(Li) gamma spectrometer for five radionuclides submitted for various comparisons. Collaboration with the NPL on the SIR efficiency curves has resulted in a mathematical model with reduced uncertainties to quantify radionuclide impurities and consequently, key comparison reference values.

**Chemistry:** The Chemistry section has laboratory programmes and coordinates international comparisons in the fields of gas analysis (air quality standards) and organic analysis (primary calibrators for laboratory medicine). The section provides the secretariat for the JCTLM and coordinates the JCTLM database of higher order certified reference materials and reference measurement procedures.

The BIPM is coordinating the ozone reference standard comparison (CCQM-P28), and measurements for the comparison were completed in March 2005. This comparison has allowed the degree of equivalence of 23 reference standards to be determined in relation to the BIPM maintained standards, and will be followed by an on-going key comparison

([BIPM.QM-K1](#)). A collaboration with the BAM on the statistical treatment of ozone comparison data has continued, and a software programme (OzonE) developed for the treatment of data. The study of systematic biases and measurement uncertainty in standard reference photometers (SRPs) has been completed, and a new uncertainty budget for the instrument will be published in collaboration with the NIST. A feasibility study has demonstrated the advantage of introducing a laser-based light source into the SRP, and a programme to develop a candidate primary ozone photometer based on a laser light source has been initiated. A gas-phase titration (GPT) facility for ozone concentration measurements has been modified and its performance and measurement uncertainty improved. The system was used in the CCQM-P28 study, producing a result consistent with that of an independently developed GPT facility, but biased with respect to the ozone photometer measurements. The source of this bias will be investigated in the future programme.

The BIPM's primary gas standard facility for the dynamic preparation of nitrogen dioxide gas standards in the range (0.5-10)  $\mu\text{mol/mol}$  has been automated and software control developed. A multiple gas mixture sampling module for this facility is currently under construction which will allow static gravimetric  $\text{NO}_2$  gas reference mixtures (prepared in cylinders) to be compared with the facility's dynamically generated reference mixtures.

A feasibility study on high accuracy comparisons of nitrogen monoxide gas standards has been completed, and presented to the CCQM's Gas Analysis Working Group. A BIPM coordinated comparison (CCQM-P73) of  $\text{NO}$  gas standards from 12 NMIs is planned to start at the end of the year.

The BIPM is coordinating subsequent rounds of the CCQM-P20 series of organic substance purity analysis comparisons, with two comparisons approved by the CCQM: CCQM-P20.e for theophylline; and CCQM-P20.f for digoxin. The substances to be studied have been prioritized taking into account the current programmes of the CCQM and the JCTLM and the ongoing requirements of laboratory medicine. Investigations into the extension of the comparison series to include clinically-important steroid hormones such as progesterone,  $\beta$ -estradiol and testosterone are also being undertaken. Two scientists and a technician have been recruited to the section, and laboratory facilities to support ongoing activities in this area have been established including capabilities for analysis by liquid chromatography with mass spectrometry, gas chromatography with mass



spectrometry, gas chromatography with a flame ionization detector and differential scanning calorimetry, supplemented by Karl Fischer titration and thermogravimetric analysis.

Collaborations to develop methods for purity determination for therapeutic drug monitoring and steroid hormones have been established with the LGC and the NMIJ, respectively. Theophylline and digoxin materials have been prepared by the LGC and will be transferred to the BIPM. The NMIJ has obtained 200 g batches of testosterone, progesterone and  $\beta$ -estradiol materials. Initial analyses of the materials have been performed at the NMIJ, and will continue at the BIPM.

#### **14.2 Criteria for BIPM technical programmes; and long-term plans**

Following the request of the 22nd CGPM and discussions by the CIPM in 2004, Prof. Wallard presented documents on the BIPM's proposed ten-year work plan and on how the BIPM sets priorities for its scientific and international collaboration programmes.

The BIPM technical and coordination programmes are funded on the general guidelines discussed by the CIPM in 2004. The following detailed criteria were used in programme setting and in the ten-year plans:

- a commitment to sustain a facility or activity on behalf of NMIs for a significant period;
- mandated activities;
- value for money from an international, rather than a national investment, network coordination, international reference facilities or transfer artefacts;
- a limited number of calibration and comparison capabilities; and
- selected front-line research.

The priorities for the BIPM's coordination work are determined by:

- the degree of impact likely to result from sustained effort;
- the degree to which the BIPM's efforts create an opportunity for a major expansion in the uptake of the SI or the development of traceability in a new area of application;
- the extent to which the partnering organization has already committed itself to the aims and objectives of the Metre Convention;

- whether, once an initial opening has been created, the work can be taken up by the partnering organization or by groups of NMIs (such as the RMOs);
- political considerations and the expressed wishes of the CGPM.

Prof. Wallard pointed out the need for a balance between these different types of activity.

Prof. Wallard then gave a brief presentation on the content of the next work programme.

Consistent with the decisions taken at the 91st CIPM and the 22nd CGPM, he presented the following proposals for the formal closure of the Length section during 2006:

- the work on infra-red lasers and development of optical lasers will stop;
- the fixed and travelling combs will be maintained as an operational facility so that the BIPM can, as the CCL requested at its meetings in 2003 and 2005, coordinate and pilot the [BIPM.L-K11](#) comparison. With time the relevant NMIs will develop a regional comb infrastructure to replace the central BIPM facility;
- the BIPM's work on gravimetry and lasers for its internal needs in, for example, the calculable capacitor, is not affected by the CIPM or CGPM decisions and will continue;
- the staff of the Length section will be transferred to another section or sections, but final decisions about the best location have not yet been taken.

After a short discussion during the meeting, the continuation of the comb for use in [BIPM.L-K11](#) during 2006 was approved by correspondence. The situation will be reviewed at the next meeting of the CIPM.

The other main points of the next work programme were as follows:

- In mass, it will be important to deal with the implications of a potential redefinition of the kilogram. These will be significant and Prof. Wallard expected that the BIPM would need to maintain a substantial competence in mass measurement. This would probably be through ensembles of platinum and silicon mass standards as it is likely to be one of the options proposed in a *mise en pratique* for any new definition. Many Member States would also continue to require the supply of platinum standards, and their calibration. The new Sartorius balance will be commissioned, providing a unique high-precision

capability for making measurements in air, vacuum or inert atmospheres. The Head of the Mass section will retire during the next work programme and an experienced replacement will need to be found before then so as to provide an overlap. It may be necessary to augment the staff, possibly on a short-term basis, as a substantial proportion of the current team are presently diverted to work on the watt balance.

- The Time section is facing new work in connection with the increasing number of frequency standards, including optical ones and, in due course, trapped ion or atom-based standards which contributed to TAI. In addition to the current GPS, the GLONASS and GALILEO networks will also need to link to UTC. In the past few years, the Time section had been reduced by 30 % and current resources would not be able to cope with the new demands for this core business.
- A new scientific member of staff is being recruited to the Electricity section. A recent survey of NMI requirements showed an increased demand for on-site comparisons of voltage and resistance. With the planned increase and the closure of the Zener source calibration service, the section will probably be able to cope.
- NMI pressures and requirements for new reference facilities and an extension to existing ones in ionizing radiation will require new resources. New project proposals will be presented in the work plan, together with the additional resources needed.
- The Chemistry section has grown substantially in the last and the current work programmes. Continued expansion of its scientific and coordination work is expected and the BIPM remains in close dialogue with international bodies, the CCQM and leading NMIs in order to keep a clear picture of their needs. Selective expansion in gas metrology and the organic programme to meet needs expressed by representatives of the international medical, food and, possibly, the sports drug testing bodies would be addressed. The aim would be to concentrate on current facilities and skills, and not to expand into areas where the basic requirements might not last and where we may lose NMI or other support. The area of biological measurements cannot be ignored and the Director's current thoughts were to explore opportunities and needs in genetically modified organisms (GMOs) or DNA measurements. The BIPM will continue to look for short-term secondments and staff exchanges but additional work would require

more scientific and technical resources. New projects will be proposed together with the staff and equipment costs.

- The watt balance project would continue well into the new programme and the Director was concerned that there may not be adequate resources. Secondments and additional short-term staff needs may need to be addressed.

In summary, as far as existing areas were concerned, the Director would be proposing an overall increase in resources for physical as well as chemical metrology. This may involve nine or ten extra staff, and expenditure on facilities, especially in ionizing radiation and chemistry, would be calculated in order to provide fully costed proposals for the next CIPM.

He has not yet come to a conclusion about the implications of recent interests in nanometrology or materials metrology, the BIPM's relation with developing countries, or the general promotion of metrology to an increasing number of international communities.

As an example of the value returned to Member States by the work of the BIPM, he gave a back-of-an-envelope estimate of the financial value of the comparisons, calibrations, coordination and other work from which a typical Member State might benefit, and showed that over several years the dotation paid has a reasonable return.

Prof. Göbel thanked Prof. Wallard for his presentation and invited questions.

Dr Luszyk remarked that it would be useful to present to the General Conference a list of activities and their costs, suggesting that this would lead to a more realistic correlation between the expectations of the Member States and the level of financial support required. Prof. Göbel agreed, adding that indeed this had been discussed by the bureau.

Dr Luszyk then expressed caution about the proposed programme on DNA, asking if a BIPM presence in this area could be significant. He pointed out that there were already a huge number of organizations involved in studies of DNA, which he recognized represented a big market, and said he would be interested to hear Dr Semerjian's comments.

Dr Semerjian noted that one of the BIPM's criteria in formulating its work programme was not to repeat what was already being done in NMIs. He expressed concern that the proposed programme for chemistry, particularly the parts concerning SO<sub>2</sub> and DNA, would do exactly that. He recognized that the area of GMOs represented an important trade issue and had

implications for internationally accepted references from an impartial body. However, the main interest in DNA was in forensics, which did not have the same international perspective. It was not clear how the BIPM could make a unique contribution, or significant impact, in the area of DNA measurement, particularly with just a few extra staff.

Prof. Göbel remarked that the BIPM sometimes had to pick up areas of work from individual NMIs, where they could be developed at the BIPM to the advantage of the international community. He added that the BIPM welcomed opportunities for staff to spend secondments at other institutes.

Prof. Wallard agreed that external secondments were indeed valuable, and noted that Dr Josephs of the BIPM Chemistry section has spent several weeks on secondment at LGC over the last year. On the uniqueness of the proposed programme, he noted that advice was sought from the Consultative Committees and their working groups, and the proposed programme in DNA had been developed with help from the CCQM BAWG. He pointed out that although much work at NMIs was done on DNA itself, relatively few groups were working on establishing metrological traceability in this area. He recognized that biotechnology was an important growth area, and the CCQM BAWG was a very active group; he thought that the BIPM would be unwise to ignore it. He explained that the SO<sub>2</sub> work was a proposal to extend the existing facility for gas measurements, at marginal cost.

Dr Semerjian agreed that bioanalysis was a huge growth area, and even a large group such as that at the NIST had to be careful with its choice of programmes. He repeated that work on SO<sub>2</sub> was already available at many NMIs. However, he could conceive a well-justified programme for the BIPM in measurement of hormones and drugs of abuse; he commented that drug-testing in sports was of international interest, and the BIPM could provide a unique role in assuring global compatibility of the results. International interest could also be used as an argument for undertaking work in the field of GMOs, although he commented that this was a more difficult area to start in, as well as being a moving target, as the industrial needs were changing rapidly.

Dr Kaarls held that there remained difficulties in making SO<sub>2</sub> measurements; the WMO, for example, has already brought in stricter requirements for environmental SO<sub>2</sub> than could currently be measured. It remained to be established whether the necessary work should be done at the BIPM or elsewhere. The CCQM GAWG, however, would like the

BIPM to pilot various forthcoming key comparisons on gases. On the proposed programme in organic chemistry, he explained that the proposal was for the BIPM to concentrate on a small part of what is not dealt with elsewhere. On GMOs, he believed that the industrial sector was indeed looking to the NMIs to provide traceability at the global level.

Dr Luszyk suggested that the main way in which the BIPM differs from the NMIs is that it has international credibility, meaning it can adopt a coordinating role. For this it needs to have technical expertise in certain areas. However, he said it was important to consider how many, and which, areas the BIPM could cover. He expressed reservations about the proposed activity in DNA.

Dr Semerjian commented that the needs of small laboratories were different from those of large ones, and warned against asking the small laboratories if they wanted the BIPM to provide a free service, as of course they would accept. He recommended that the BIPM concentrate on identifying niche needs not currently being met, and only move into new fields if they are sure to have the long-term support of the NMIs.

Prof. Wallard thanked Dr Semerjian for his comments, and pointed out that of course the services provided by the BIPM were not free, but cost the price of the subscription to the Metre Convention. He drew attention to diagrams recently published on the BIPM website (see under <http://www.bipm.org/en/bipm/>) summarizing some of the BIPM services provided to Member States, pointing out that very few Member States do not benefit from the services currently offered. A subscription to the Metre Convention means a subscription to the whole package.

Dr Bennett commented that it was interesting to see that the larger countries generally benefited from the higher level services. But he commented that it was not enough for the BIPM to pilot key comparisons; it was important for it to have a niche activity that the NMIs could not meet. He agreed with Dr Luszyk's reservations about the DNA programme, warning that this was a difficult area and that when setting up its new biotechnology group, the NPL had concluded they would need about forty people in order to make an impact.

Dr Hengstberger recalled that one of the main reasons for the BIPM venturing into chemical metrology at the outset was not to make a significant impact in specific areas, but to acquire the necessary background and expertise required for dealing with other international organizations. He remarked that the objective of the BIPM's work programme should be for

the BIPM to optimize its credibility and give the best possible return on investment; this often took a long time. He called on the CIPM, rather than just comparing the technological impact of the various programmes, to consider in which areas the BIPM needed to maintain or establish scientific credibility.

Prof. Issaev recognized that measurements of food and air were important, and that some activity was necessary in the domain of health and medicine, but he warned against undertaking more work in chemistry at the expense of the traditional, and still essential, fields such as time, frequency and length metrology.

Prof. Wallard understood Prof. Issaev's concerns about changing the balance of resources in favour of chemistry, but pointed out that in terms of staffing levels, the current programme represented 17 % of BIPM resources devoted to chemistry and 83 % to physics; the proposed programme would represent 20 % chemistry and 80 % physics. Dr Kaarls added that many NMIs do not have their own activity in chemistry, and the BIPM's work programme is presented on behalf of all of the NMIs and DIs.

Dr Carneiro was of the opinion that the proposed work programme was basically in the right direction, and just required fine tuning. He thought that the portfolio presented would be attractive to both large and small institutes, and the BIPM should not be dissuaded by comments along the lines of it being "too small to make a difference". He emphasized the importance of the BIPM making partnerships, although he agreed that the proposal to move into biotechnology was controversial. He thought that the heads of the physics sections at the BIPM should be encouraged to be as aggressive in their statements of needs as the Head of the Chemistry section; this was an important part of the planning process. He saw little merit in arguing about the distinction between physical and chemical metrology, saying they were two parts of the same subject and both areas reflected national needs. He commented that one never got more than one asked for.

Overall, he expressed his admiration for the way the BIPM was offering a big programme for a reduced budget. However he commented that the organizational structure of the bodies reporting to the CIPM (i.e. the Consultative Committees and their working groups, and the various Joint Committees) was overly cumbersome and could be streamlined.

Dr Schwitz remarked that this discussion on the work programme was the most important item on the agenda, and he would like to see the CIPM go

further with developing criteria and defining key indicators that would help determine the resources allocated to specific programmes. He called on the Committee to consider how the main work programme of the BIPM fitted in and complemented the work of the NMIs. He was in favour of developing the work programme as presented and stressed the need of continuing to coordinate work and lead comparisons.

Dr Valdés wondered whether it would be possible for governments to support their national programmes as well as the BIPM programme. It was important, however, to separate the metrological demands from the issue of finances, and the CIPM should present a programme based on identified needs. He saw a real need for the chemical work, citing the need to comply with international legislation. A country like Argentina could not expect to, nor afford to, do this by itself. Sharing costs in this way was a persuasive argument.

Dr Inglis commented that it was difficult to quantify the benefit of metrology, but he was troubled to hear colleagues expressing the view that smaller countries might benefit more from certain areas of work. He argued that there was real value in the work of the Metre Convention, in terms of its impact on global trade and economy; this was more than a question of the value provided to individual laboratories. The BIPM was not trying to compete with NMIs, nor to make a commercial breakthrough. It was important to choose the areas in which the BIPM should be active, so as to maximize the international impact of its work. Like Dr Hengstberger, he underlined the importance of the BIPM having the necessary credibility to set up links and to take an international lead, which would then bring benefits to all Member States. He commented that the debate about the size of the groups involved could be misleading; what mattered was whether they could offer added value to the NMIs.

Prof. Moscati reminded members of the results of a survey of NMI directors carried out before the last CGPM, from which it was clear that among the values most appreciated in the BIPM were its integrity and independence. In defining the BIPM's work programme, it was important to identify areas in which these qualities were required. Prof. Moscati added that although the cost of developing a measurement system in food, medicine, etc. was significant, the cost of a conflict in either domain would also be expensive.

Mr Énard took up the comments of Dr Inglis, agreeing that it was important to optimize the benefits returned to the metrology community. For any proposed project, the BIPM should estimate the critical mass required, the



likely duration of the project, the capital investment and running costs, and the availability of the appropriate expertise. He also asked to have information on what kinds of collaboration or flow of benefits to users were possible. He argued that if no such information was possible, then the project should be abandoned. Finally, he suggested that the BIPM could designate other laboratories in some areas.

Prof. Wallard said that the bureau understood the importance of networking. To undertake certain work programmes at designated laboratories, however, would not eliminate the need for the work to be funded and may raise questions about independence.

Dr Bennett emphasized the importance of presenting the benefits of the proposed work programme, especially to the governments being asked to fund them. He said that the governments would understand arguments such as disputes over GMOs and drug testing. He recommended adopting techniques such as roadmapping, to establish triggers and targets, then develop the underlying programmes.

Dr Semerjian supported this suggestion, saying that he was keen to present a stronger case for the BIPM's technical programmes. He underlined the importance of a shift to coordination and secretarial activities, which would inevitably increase, and contended that scientific credibility was not the issue. He accepted the point about the value of scientific credibility but said that this did not necessarily link directly to the need for a larger programme. This had to be justified in other ways and a detailed case made. He recommended that the CIPM and BIPM first identify the needs of the world at large (considering driving forces such as political and scientific challenges), and then identify where the BIPM can play a unique role. He called for discussions to be held at a more detailed level, suggesting that key-note speakers be invited to explain why individual projects were necessary, so that the cases could be compared. Prof. Wallard replied that such discussions took place in the Consultative Committees, but Dr Semerjian said that the CCQM had not yet discussed specific projects. Dr Semerjian and Dr Luszyk supported an approach which looked, on a project by project basis, at the case for a new activity. The justification should identify user benefits, potential financial savings to the NMIs, and whether the project was directed towards international regulatory issues. It was also important for the CIPM to consider cross-disciplinary areas such as nanotechnology.

Prof. Göbel remarked that the JCTLM had been set up in response to an external trigger, the European Community's directive on *in vitro* diagnostic devices. Dr Semerjian recognized this, but commented that it was a coordinatory rather than laboratory role. Dr Luszyk repeated Dr Inglis' caution not to consider the benefits to individual countries over the benefits to the international system of trade. Prof. Issaev concurred. He added that the primary responsibility of the Metre Convention should be to assure the traceability of measurement results.

Prof. Göbel summarized the discussion so far, noting the Committee's general view that, particularly in bioanalysis, the choice of the domain of activity must be very clear. It was important to identify the BIPM's unique role and what could be done with the proposed resources. He noted the need to break down the criteria in order to develop the work programme. Prof. Wallard would transmit the Committee's comments to the BIPM staff, and draw up a draft work programme and budget in time for the next meeting of the CIPM. Dr Semerjian requested that it should be distributed well in advance of the CIPM meeting, and Prof. Göbel agreed that an early draft would be ready in time for the bureau meeting in March and could be distributed to all CIPM members in the late spring.

Dr Semerjian underlined his support for the BIPM, and his desire to make the programmatic decision making more robust to promote the well-being of the BIPM. Prof. Göbel and Prof. Wallard thanked all the CIPM members for their comments and support, saying the discussion had been helpful.

Dr Luszyk asked whether the BIPM would still be able to provide support for the Consultative Committees. Prof. Wallard agreed that this was an area of concern, pointing out that Dr Stock was already Executive Secretary of the CCPR and CCT, and on the retirement of Dr Witt would also inherit the CCEM. This was too much. Responsibility for the CCT will therefore be transferred to Dr Davis. Dr Bennett confirmed that the NPL would provide the secretariat for the *Ad hoc* Working Group on Materials.

Dr Kaarls commented that in some Consultative Committees, the working groups are supported by NMI staff, whereas others were supported by BIPM staff. He recommended that in general they should be run by NMI staff as far as possible. Prof. Wallard commented, however, that in some cases this could lead to the BIPM losing influence in, or awareness of the work of, the group, which could lead to problems such as experienced with the CCL WGDM.

Dr Semerjian asked whether retired staff could be asked to take on the support roles for the Committees or could contribute to technical programmes. Prof. Wallard considered that this would be difficult for the roles of Executive Secretary, as they need continuity. However, he welcomed the suggestion for agreed scientific projects, saying that the BIPM would provide support for the cost of living. This might be of particular interest to NMI staff taking early retirement.

Dr Luszyk asked if the BIPM could have contracts with individuals for particular jobs, such as hiring a quarter-time person for five years. Mrs Perent confirmed that the BIPM statute had provision for this, and indeed that there would be no problem in adapting a contract to suit a particular post. Prof. Wallard added that of course the BIPM can and does employ a number of people on a contractual basis. Dr Semerjian commented that this was an important point, because in such cases the person would no longer be an NMI employee, but an independent person. They would be receiving their pension from their national government, but living in Paris and receiving subsistence from the BIPM. Dr Inglis cited the example of Dr Michael Kenny, who had had a short-term contract with the BIPM to work on the Avogadro Project after his retirement from NMIA.

Dr Hengstberger noted that the role of Executive Secretary was a permanent support role, and could not be undertaken in, for example, a one-month time slot. Dr Tanaka raised the issue of impartiality of a contractual employee in the role of Executive Secretary. Prof. Wallard commented that the JCRB Executive Secretary for example, had to be impartial, and loyal to the BIPM.

Prof. Göbel then invited comments from the CC Presidents in particular, on the proposed ten-year plans of the individual scientific sections.

Dr Tanaka had no comments on the mass programme.

Dr Chung, although unhappy to see the Length section being closed, understood the reasons behind the decision. He suggested that to encourage support of the increased dotation to be proposed at the next CGPM, the CIPM should distribute to NMIs the list of projects and reasons for them, so that where possible the NMIs could help persuade the national governments to support the work programme. Prof. Göbel noted the comments, and added that although the Length section would be formally closed in 2006, some high-quality activities would be transferred to the Time section.

Prof. Issaev suggested that the term “merged” should be used rather than “closed”, but Prof. Göbel confirmed that as “merge” implied that the

activity continued, this was not appropriate. Dr Valdés asked who would have responsibility for the remaining activities in Length. Prof. Wallard confirmed that most of the staff would be under the responsibility of Dr Arias.

Dr Inglis supported the full electricity programme, underlining the importance of recruiting a new senior member of the section in order to assure the various projects, and particularly the watt balance.

Prof. Moscati supported the programme proposed by the Ionizing Radiation section, commenting that there was strong demand from the CCRI Sections and their working groups. He noted that the staff of the section were already overloaded and more areas of work needed to be opened up. Prof. Göbel remarked that demand from a CC was not sufficient justification to embark on a new programme at the BIPM.

Prof. Leschiutta commented that the programme of the Time section was adequate at present, although staff resources were stretched.

In response to a comment from Prof. Issaev, Prof. Wallard confirmed that the final document would be presented in a homogeneous style. Dr Inglis emphasized the importance of presenting an integrated picture, showing the collaborations between the chemical and physical sections. Prof. Göbel added that the final programme would probably be reduced.

Dr Schwitz commented that it was important also to consider the communications role of the BIPM in the CIPM MRA. Prof. Wallard agreed that the BIPM had a role in public relations, and he was conscious of the need to promote the BIPM and international metrology. He noted that the BIPM website was now the BIPM's most important means of communication with the outside world. It continues to evolve and grow, opening up more information about the BIPM. The website is the BIPM's main vehicle for public relations, but a new printed brochure will also be produced during 2006, and the micro SI Brochure should also create publicity for the BIPM.

Dr Schwitz congratulated the BIPM on the work done over the last year, and agreed that retired staff could also help. Prof. Wallard agreed that this might be appropriate for specific projects. He drew attention to the project work of a History of Science student who worked with the Publications section during two months in 2005, to identify and catalogue a number of the old scientific instruments. This work is expected to lead to a new printed booklet, and a new section on the BIPM website.

Prof. Göbel asked whether the BIPM could react to current events, such as issuing a press release on the Nobel Prizes 2005. Prof. Wallard confirmed that he would release a text for World Metrology Day in 2006, although the BIPM would not normally issue a statement for the Nobel Prizes.

Prof. Gao Jie confirmed his support of the BIPM's proposed programme, saying it was appropriate and the long-term plan satisfactory. The Chinese government considered that the BIPM had finished the transition from where it was ten years ago, when its work was restricted to precise measurements, to a position now where it is more closely connected with society, industry, and the other international organizations. He believed that the establishment of the Chemistry section and the forthcoming *Ad hoc* Working Group on Materials were both practical and achievable.

Prof. Göbel thanked Prof. Gao Jie for his constructive comments, and concluded the discussion on this item.

#### **14.3 Management review of the BIPM Quality System**

As reported under 2.7.1 above, Dr Kaarls reminded members that he had attended the annual management review of the BIPM Quality System in August 2005. The QS was working well, and no problems had been raised.

In answer to a question from Dr Schwitz, he confirmed that both the QS and the scientific services were peer-reviewed. Dr Schwitz commended this, being in line with all NMIs and DIs participating in the CIPM MRA.

Dr Inglis commented that this was the third major review of the BIPM QS and complimented Dr Köhler and all BIPM staff on its success.

#### **14.4 Presentations of the work of the BIPM by the Section Heads; laboratory visits**

This year the format of presentations to the CIPM was changed. During the morning of Wednesday 5 October, the seven Heads of sections gave 30 minute presentations on the progress achieved since last year, significant issues likely to arise in the coming year, and an overview of the proposed ten-year plan. During the afternoon the CIPM visited the BIPM laboratories.

Following the visits, Dr Semerjian commented that he had been shocked to see members of the Workshop staff not wearing safety glasses. Prof. Wallard replied that this should not have happened, but confirmed that

procedures were being brought in and he had already spoken with the staff concerned. A special review of the Workshop was carried out recently.

Prof. Göbel said he had very much appreciated both the talks and the laboratory visits, and thanked all the BIPM staff for their efforts. On behalf of the Heads of sections, Dr Davis replied that the staff were pleased to know that their work would be seen by the CIPM, saying that some laboratories had previously had few visitors during the open afternoon.

#### 14.5 Depository of the metric prototypes

The visit to the depository of the metric prototypes in the Pavillon de Breteuil took place at 16 h 45 on 5 October 2005, in the presence of the President of the CIPM, the Director of the BIPM, and the representatives of the Curator of the Archives de France.

The three keys necessary to open the depository were assembled: the key entrusted to the care of the Director of the BIPM, the one deposited at the Archives Nationales in Paris, brought by Mr Gérard Ermisse, and finally the one kept by the President of the CIPM.

The doors of the vault and the safe having been opened, the presence in the safe of the international prototype of the kilogram and its official copies was verified.

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

temperature:	20 °C
maximum temperature:	23 °C
minimum temperature:	20.5 °C
relative humidity:	50 %

The safe and the doors of the vault were then locked.

The Director of the BIPM,	For the Curator of the Archives Nationales,	The President of the CIPM,
A.J. Wallard	G. Ermisse	E.O. Göbel

## 15 PREPARATION FOR THE 23rd GENERAL CONFERENCE

### 15.1 “Kaarls Report II”

Dr Kaarls made a brief presentation of the areas to be included in the planned 2007 update of the “Kaarls Report” on evolving needs for metrology and the role of the BIPM.

Prof. Göbel reminded members that the aim of the document was to describe the overall picture, primarily for non-metrologists, and that of course it covered a much broader range of activities than could be included in the BIPM work programme. The work programme presented to the 23rd CGPM would take up selected areas.

Dr Semerjian asked when a preliminary draft of the text would be ready for consultation, and proposed that Dr Kaarls identify certain people to undertake particular tasks to aid in the preparation of the new report. He noted that it was important for the document to portray a broad picture, showing the needs of NMIs as well as the BIPM. Dr Kaarls replied that he was preparing the draft in close consultation with the NMIs, and that the first draft should be ready early in 2006.

With relation to the 23rd CGPM, Dr Lusztyk pointed out that the document would be a crucial part of the evidence used by NMIs trying to persuade their governments to support the proposed dotation, and said it was essential to have the unanimous support of the CIPM. Dr Valdés added that an international report on future needs for metrology in Argentina, making close reference to the previous Kaarls Report, had been drawn up in collaboration with the CENAM and PTB. He noted that it was essential to underline that individual countries, not just the BIPM, required an increased budget for metrology.

Prof. Göbel agreed that this would be an important document both at the national and international levels, and said the bureau would discuss the idea of a small working group to advise Dr Kaarls on his report. He commented that the new statement of needs had to be produced, before reactions to the required budget could be tested.

## 15.2 Proposed dates

Prof. Wallard informed the Committee that the 23rd CGPM was provisionally scheduled for the week 15 to 19 October 2007, but said that these dates still had to be approved by the French Ministry for Foreign Affairs.

## 16 METROLOGIA

Dr Jeffrey Williams, Editor of *Metrologia*, presented a brief report on the journal.

Dr Williams commented that since the beginning of 2003, *Metrologia* has been produced in partnership with Institute of Physics Publishing (IOPP) Ltd.. This partnership between BIPM and IOPP was established by a contract for an initial period of five years. Consequently, we will have to begin renegotiations with IOPP in 2006, to prepare a new contract to come into force on termination of the present contract at the end of 2007.

As an example of how well the technical details of the production of *Metrologia* are progressing, Dr Williams presented data on the average times from acceptance of a manuscript until its publication on-line on the web, and from acceptance to its publication in the printed journal. These times, which are being reduced, demonstrate that the editorial and publication processes involving BIPM and IOPP, respectively, are working well. The shortening of the period between submission and publishing is being reflected in comments from authors in some NMIs who have a time constraint for the publishing of their data. They are choosing to publish in *Metrologia* because of the rapidity of the publishing process.

The journal appears on time and we benefit from the extensive marketing network of IOPP to assist in maintaining the subscriptions levels of the journal at a time when subscription levels are falling for the majority of technical scientific journals. Over the last year, there have been two special issues of *Metrologia*: one on *Electrical Charge* and the other to celebrate *50 Years of Atomic Timekeeping*.



In addition to appearing in the printed journal, all accepted articles are freely available for one month on the *Metrologia* section of the website of IOPP (<http://www.iop.org/EJ/journal/Met>).

A recent project has been the digitization of the whole archive of *Metrologia*. This process of digitization was undertaken by IOPP on our behalf, and was completed at the end of 2004. On behalf of the BIPM, IOPP is marketing this *Metrologia* Archive as part of the archive of papers published in their journals.

Dr Williams presented data showing that the impact factor of the journal is increasing rapidly. The impact factor for 2004 (based on papers published in 2003 and 2004) is 1.314.

Dr Williams commented that it is likely that the impact factor will further increase as papers published in 2005 have gained extensive media coverage. It is important for us to achieve and maintain an impact factor above 1.0 as this is typically the cut-off value that librarians and subscriptions managers look at when they are seeking which journals with low impact factor to cut from their budgets.

Institutional subscriptions are falling continually; this decline is to be regretted as it reduces the income coming to the BIPM from the journal. However, the fact that the journal is now distributed in a pack with other IOPP titles means that it is now more widely available. In this way, we are using the pack subscription route offered by IOPP as a communication tool to make *Metrologia* and metrology more widely available to the scientific and technical community. The pack subscriptions are also increasing, and are thus generally increasing levels of revenue for the BIPM.

The *Technical Supplement* to *Metrologia* was created in 2002 to provide a convenient means of publishing the results of comparisons and pilot studies. The *Supplement* is in good health, having published 27 abstracts in 2002, 67 in 2003, 36 in 2004 and 26 already online in 2005, with more in the pipeline.

Prof. Göbel thanked Dr Williams for his report and invited questions.

Prof. Moscati congratulated Dr Williams on the impact factor for 2004, commenting that it was an outstanding result. Dr Williams noted that it was even celebrated on the IOPP website. Dr Semerjian asked how 1.314 compared with the impact factor of other journals, and Dr Williams replied that it was higher than that of *Measurement Science and Technology* (1.118 for 2004) but less than that of *Phys. Rev. Lett.* (about 6) or *Nature* and *Science* (over 10).

Prof. Issaev asked about the average time from submission to publication. Dr Williams confirmed that this had been significantly reduced, and was now about two to three months, assisted by early publication of the articles online by the IOPP. He added that this was helping to attract authors to the journal. Prof. Mills agreed that authors were most interested in the delay between acceptance and publication, which had been just one month for one of his recent papers.

In answer to queries from Prof. Göbel and Prof. Issaev, Dr Williams noted that the rejection rate was about 15 %, and that 15 to 20 papers were currently accepted and awaiting publication in the printed journal.

Dr Bennett drew attention to comments from Dr Williams that indicated that the number of papers from Europe being published in *Metrologia* had fallen. Dr Williams confirmed that the number was falling slowly, but there was no concern about a dearth of manuscripts.

In answer to a query from Dr Semerjian, Dr Williams confirmed that *Metrologia* would continue to organize one or two special issues per year. In 2006 there would be a special issue on statistics and another containing the proceedings of the NEWRAD conference. Prof. Issaev congratulated Dr Williams on his management of the journal, saying he had particularly enjoyed the special issue on atomic clocks, published in 2005.

Prof. Göbel commented that the move to publish *Metrologia* with the IOPP had been a good one.

## 17 ADMINISTRATIVE AND FINANCIAL AFFAIRS

### 17.1 *Rapport annuel aux Gouvernements for 2004; quietus*

Mrs Perent, Administrator of the BIPM, presented the *Rapport annuel aux Gouvernements des Hautes parties contractantes sur la situation administrative et financière du Bureau international des poids et mesures en 2004*, which had been distributed in March 2005.

The report of the auditors for 2004 was also presented and the required formal discharge was given to the Director and Administrator of the BIPM for 2004.

**17.2 Member States in arrears; discretionary contributions**

The Committee asked which Member States had not confirmed their payment of the discretionary contribution to the dotation. Mrs Perent confirmed that thirty-nine Member States had responded, and responses from twelve States were outstanding; these included the five Member States in arrears (Cameroon, the Dominican Republic, the Islamic Republic of Iran, the Democratic People's Republic of Korea, and Uruguay) and the following seven States: Argentina, Brazil, Egypt, Indonesia, Israel, the United States, and Venezuela.

**17.3 Progress report on the 2005 exercise; budget for 2006**

Mrs Perent presented a summary of the BIPM's accounts for 2005, which were approved without comment.

She then presented a summary of the proposed budget for 2006 and requested the Committee's authorization to transfer 356 000 euros from the reserves to the Building Reserve Fund, for the refurbishment of the old workshop into meeting rooms. She pointed out that the planned purchase of platinum this year would also be from the reserves. The budget and transfer were approved, after a brief discussion mainly on the form of presentation. In particular, Dr Semerjian suggested that transfers from reserve funds should be indicated as a special line in the budget. Dr Quinn noted that, to avoid confusion, the annual budget was usually presented in a form as close as possible to the sum voted at the CGPM, and Prof. Wallard explained that all transfers were indicated in the *Rapport annuel aux Gouvernements*.

Dr Lusztyk asked why the income related to repayments of arrears was not redistributed to Member States, rather than being part of the BIPM income.

Mrs Perent explained that the arrears were generally related to undistributed contributions. When a Member State has arrears for more than 3 years, these contributions are distributed among other Member States. When the Member State pays its distributed contributions, the other Member States receive a reimbursement.

**Budget for 2006**

<b>Income</b>		euros
<i>Budgetary income:</i>		
1. Contributions from the States		9 906 261
2. Interest on capital		269 000
3. Miscellaneous income		103 000
4. Subscriptions from the Associates		182 874
5. <i>Metrologia</i>		88 000
6. Transfer from Account I.- Ordinary funds		303 865
<b>Total</b>		<b>10 853 000</b>
<b>Expenditure</b>		
<i>A. Staff expenses:</i>		
1. Salaries	4 403 000	} 5 912 500
2. Family and social allowances	1 033 000	
3. Social expenses	476 500	
<i>B. Contribution to the pension fund:</i>		1 740 000
<i>C. Operating expenses:</i>		
1. Heating, water, electrical energy	187 700	} 1 114 800
2. Insurance	39 500	
3. Publications	122 500	
4. Office expenses	138 400	
5. Meeting expenses	75 000	
6. Travel expenses and freight charges	346 700	
7. Library	176 000	
8. Bureau of the CIPM	29 000	
<i>D. Laboratories:</i>		1 720 000
<i>E. Buildings (major maintenance and renovation):</i>		279 000
<i>F. Miscellaneous and unforeseen expenses:</i>		86 700
<b>Total</b>		<b>10 853 000</b>

**17.4 BIPM staff: promotions, departures, recruitment**

In response to Dr Luszyk's query in 2004, Prof. Wallard briefly summarized the hierarchy of grades at the BIPM. He said that there are two main factors to consider in promotions, in addition to competence: age, and seniority in the organization.

The CIPM approved the promotion of Susanne Picard to *physicien principal* with effect from 1 January 2005.

**17.5 BIPM staff statute**

Mrs Perent presented a draft *Code of Conduct* for BIPM staff, which had been drawn up in collaboration with the Statute Commission. The text of the document was largely inspired by the codes of conduct in place at other international organizations. The Committee welcomed the document and noted that the *Code*, like the *Safety Manual*, should apply to all staff including staff on secondment. A minor rewording to page 4 was requested, to make this clear. The CIPM subsequently considered and approved this modification by correspondence.

The CIPM also approved a proposal presented by Prof. Wallard, that the salary scale for caretakers (currently grades 3 to 6) should be extended to include grade 7.

**17.6 Actuarial study of the BIPM pension fund**

Mrs Perent presented a brief report on the latest actuarial study of the BIPM pension fund. She reminded the Committee that such studies are carried out regularly, and the results of the 2005 study confirm those of the previous one. The study indicates that the BIPM pension fund is financially sound for the next 35 years. Mrs Perent recommended that the current policy of increasing the BIPM budgetary contribution annually by 2 % of salaries should continue, and that any opportunity to increase the level of the assets of the pension fund should also be considered, to assure a healthy long-term situation.

Prof. Göbel thanked Mrs Perent for her report, noting that no action was required at present.

Dr Semerjian asked whether the retirement age was fixed. Mrs Perent replied that the BIPM Statute fixed the maximum retirement age at 65.

## **18 OTHER BUSINESS**

### **18.1 Nanometrology**

Dr Carneiro gave a short presentation on nanometrology, highlighting the activities (including supplementary comparisons) of several Consultative Committees in this area (see the work of the CCEM, CCL and CCQM). However, he pointed out that Appendix C of the CIPM MRA currently contained no CMCs with “nano” in the title, which makes it difficult to find claimed measurement capabilities in this area. He noted that such CMCs are of particular importance to the semiconductor industry.

Dr Semerjian agreed that it was an important area to consider and noted that a workshop on nanometrology had been organized in the United States in 2004, as part of the national strategic planning activity. The proceedings of this meeting have now been published.

Prof. Göbel requested that the CC Presidents address the issue of nanometrology, to identify and report back on existing and potential areas of activity.

### **18.2 Miscellaneous meetings**

Prof. Wallard informed the Committee that work would soon begin on the organization of a BIPM Summer School for 2008, from 30 June to 11 July.

Prof. Leschiutta reminded members that the Varenna Summer School would be held in July 2006, the week after the CPEM meeting in Turin. Between sixty and eighty students were expected to attend, a third of whom would receive a grant towards travel and subsistence.

Prof. Moscati extended an invitation to participate in the IMEKO Congress in Rio de Janeiro, 17-20 September 2006. The deadline for submission of abstracts was 3 November 2005.

### **18.3 Nobel prizes 2005**

The CIPM addressed letters of congratulation to a number of winners of the Nobel Prizes 2005 for Physics and Peace, announced during the meeting. Dr John L. Hall (University of Colorado, JILA; NIST Boulder) and Dr Theodor W. Hänsch (Max-Planck-Institut für Quantenoptik, Garching;

Ludwig-Maximilians-Universität, Munich) were awarded a Nobel prize for their contributions to the development of laser-based precision spectroscopy, including the optical frequency comb technique. The prize for peace was awarded jointly to the International Atomic Energy Agency (IAEA) and Mohamed El-Baradei (Director General of IAEA) for their efforts to prevent nuclear energy from being used for military purposes and to ensure that nuclear energy for peaceful purposes is used in the safest possible way.

#### **18.4 Treatment of documents, and meeting dates**

Dr Semerjian commented that it would be useful to discuss the various types of document presented to the CIPM (proposals, policy documents, recommendations, etc.), and the rules for decision making. In particular, he asked about the status of documents approved by the JCRB.

Prof. Wallard explained that the terms of reference of the JCRB were that it was a coordinatory organization, charged, amongst other things, with making policy suggestions to the CIPM. Policy documents prepared by the JCRB are therefore submitted to the CIPM for approval. Prof. Wallard added that the 15th meeting of the JCRB, in September 2005, had discussed operational issues rather than policy issues, and that these did not require approval by the CIPM. Dr Inglis added that the CIPM minutes should indicate whenever a document was approved. He hoped that there would be fewer documents at future meetings.

Prof. Göbel and Prof. Wallard accepted a suggestion from Dr Schwitz, that the handling of documents for meetings of the CIPM and other bodies should be included within the BIPM Quality System.

Dr Semerjian commented that he had had to download many of the documents when he arrived in France, because they had not been available on the website before his departure from the United States. He suggested that a two-week cut-off date should be imposed before the meeting, so that members had the opportunity to study all documents in advance of the meeting, and the meeting itself could be devoted to discussion.

He repeated his request that the schedule of meetings be altered, in particular that the JCRB and Directors' Meetings either be separated, or held during the same week as the CIPM meeting, to avoid the necessity of a two-week commitment.

## **19 DATE OF NEXT MEETING**

The 95th meeting of the CIPM will take place at the Pavillon de Breteuil from Tuesday 10 October to Friday 13 October 2006. The President closed the 94th meeting noting that it had been very productive, and thanking the Committee for their contributions.



## RECOMMENDATIONS ADOPTED BY THE INTERNATIONAL COMMITTEE FOR WEIGHTS AND MEASURES

### RECOMMENDATION 1 (CI-2005):

#### Preparative steps towards new definitions of the kilogram, the ampere, the kelvin and the mole in terms of fundamental constants

The International Committee for Weights and Measures (CIPM),

**considering**

- Resolution 7 of the 21st General Conference on Weights and Measures (CGPM), 1999, concerning a future definition of the kilogram;
- the recent, 2005, Recommendations of the Consultative Committee for Mass and Related Quantities (CCM), the Consultative Committee for Electricity and Magnetism (CCEM), the Consultative Committee for Amount of Substance: Metrology in Chemistry (CCQM) and the Consultative Committee for Thermometry (CCT) concerning proposals for and matters related to changes in the definitions of the kilogram, the ampere and the kelvin;
- the Recommendation of the CCU [Recommendation U 1 (2005)] which brings together all of the major points of these other recommendations and which requests that the CIPM:
  - approve in principle the preparation of new definitions and *mises en pratique* of the kilogram, the ampere and the kelvin so that if the results of experimental measurements over the next few years are indeed acceptable, all having been agreed with the various Consultative Committees and other relevant bodies, the CIPM can prepare proposals to be put to Member States of the Metre Convention in time for possible adoption by the 24th CGPM in 2011;
  - give consideration to the possibility of redefining, at the same time, the mole in terms of a fixed value of the Avogadro constant;
  - prepare a Draft Resolution that may be put to the 23rd CGPM in 2007 to alert Member States to these activities;

- further encourage National Metrology Institutes to pursue national funding to support continued relevant research in order to facilitate the changes suggested here and improve our knowledge of the relevant fundamental constants, with a view to further improvement in the International System of Units;
- the need for careful consideration to be given to both the form and content of possible new definitions of these units, not only individually but also taken as an ensemble;

**approves**, in principle, the preparation of the new definitions, as requested by the CCU in its Recommendation cited above;

**invites** all Consultative Committees

- particularly the CCM, CCEM, CCQM and CCT, to consider the implications of changing the definitions of the above-mentioned base units of the SI, and to submit a report to the CIPM not later than June 2007;
- to monitor closely the results of new experiments relevant to the possible new definitions, to identify necessary conditions to be met before proceeding with changing the definitions, and to consider, in particular, the alternative ways of redefining the above mentioned units;
- to solicit input from the wider scientific and technical community on this important matter;

**recommends** that National Metrology Institutes

- should pursue vigorously their work presently underway aimed at providing the best possible values of the fundamental constants needed for the redefinitions now being considered;
- should prepare for the long term maintenance of those experiments that will, in due course, be necessary for the practical realization of the new definitions.

**RECOMMENDATION 2 (CI-2005):  
Clarification of the definition of the kelvin, unit of thermodynamic  
temperature**

The International Committee for Weights and Measures (CIPM),

**considering**

- that the kelvin, unit of thermodynamic temperature, is defined as the fraction  $1/273.16$  of the thermodynamic temperature of the triple point of water,
- that the temperature of the triple point depends on the relative amount of isotopes of hydrogen and oxygen present in the sample of water used,
- that this effect is now one of the major sources of the observed variability between different realizations of the water triple point,

**decides**

- that the definition of the kelvin refer to water of a specified isotopic composition,
- that this composition be:
  - 0.000 155 76 mole of  $^2\text{H}$  per mole of  $^1\text{H}$ ,
  - 0.000 379 9 mole of  $^{17}\text{O}$  per mole of  $^{16}\text{O}$ , and
  - 0.002 005 2 mole of  $^{18}\text{O}$  per mole of  $^{16}\text{O}$ ,

which is the composition of the International Atomic Energy Agency reference material Vienna Standard Mean Ocean Water (VSMOW), as recommended by IUPAC in “Atomic Weights of the Elements: Review 2000”.

- that this composition be stated in a note attached to the definition of the kelvin in the SI brochure as follows:

“This definition refers to water having the isotopic composition defined exactly by the following amount-of-substance ratios: 0.000 155 76 mole of  $^2\text{H}$  per mole of  $^1\text{H}$ , 0.000 379 9 mole of  $^{17}\text{O}$  per mole of  $^{16}\text{O}$  and 0.002 005 2 mole of  $^{18}\text{O}$  per mole of  $^{16}\text{O}$ ”.

**RECOMMENDATION 3 (CI-2005):**  
**Revision of the *Mise en pratique* list of recommended radiations**

The International Committee for Weights and Measures (CIPM),

**considering** that:

- improved frequency values for radiations of some high-stability cold ion and cold atom standards already documented in the recommended radiations list have recently become available;
- improved frequency values for the infra-red gas-cell-based optical frequency standard in the optical telecommunications region, already documented in the recommended radiations list, have been determined;
- improved frequency values for certain iodine gas-cell standard, already documented in the subsidiary recommended source list, have been determined;
- frequencies of new cold atoms, of atoms in the near-infrared region and of molecules in the optical telecommunications region have been determined by femtosecond comb-based frequency measurements for the first time;

**decides** that the list of *recommended radiations* be revised to include the following:

- updated frequency values for the single trapped  $^{88}\text{Sr}^+$  ion quadrupole transition, the single trapped  $^{199}\text{Hg}^+$  quadrupole transition and the single trapped  $^{171}\text{Yb}^+$  quadrupole transition;
- an updated frequency value for the Ca atom transition;
- an updated frequency value for the  $\text{C}_2\text{H}_2$ -stabilized standard at 1.54  $\mu\text{m}$ ;
- an updated frequency value for the  $\text{I}_2$ -stabilized standard at 515 nm;
- the addition of the  $^{87}\text{Sr}$  atom transition at 698 nm;
- the addition of the  $^{87}\text{Rb}$  atom two-photon transitions at 760 nm;
- the addition of the  $^{12}\text{C}_2\text{H}_2$  ( $\nu_1 + \nu_3$ ) band and the  $^{13}\text{C}_2\text{H}_2$  ( $\nu_1 + \nu_3$ ) and ( $\nu_1 + \nu_3 + \nu_4 + \nu_5$ ) bands at 1.54  $\mu\text{m}$ .

## LIST OF ACRONYMS USED IN THE PRESENT VOLUME

### 1 Acronyms for laboratories, committees and conferences\*

AHWGV	<i>Ad hoc</i> Working Group on Viscosity
ANMET	Asia Pacific Economic Cooperation (APEC) Network for Materials Evaluation Technology
APMP	Asia/Pacific Metrology Programme
ASTM	American Society for Testing and Materials, West Conshohocken, PA (United States)
BAM	Bundesanstalt für Materialforschung und -prüfung, Berlin (Germany)
BAWG	CCQM Working Group on Bioanalysis
BIML	Bureau International de Métrologie Légale
BIPM	International Bureau of Weights and Measures/ Bureau International des Poids et Mesures
CARICOM	Caribbean Community
CC	Consultative Committee of the CIPM
CCAUV	Consultative Committee for Acoustics, Ultrasound and Vibration/Comité Consultatif de l'Acoustique, des Ultrasons et des Vibrations
CCEM	Consultative Committee for Electricity and Magnetism/ Comité Consultatif d'Électricité et Magnétisme
CCL	Consultative Committee for Length/Comité Consultatif des Longueurs
CCM	Consultative Committee for Mass and Related Quantities/ Comité Consultatif pour la Masse et les Grandeurs Apparentées
CCPR	Consultative Committee for Photometry and Radiometry/ Comité Consultatif de Photométrie et Radiométrie
CCQM	Consultative Committee for Amount of Substance: Metrology in Chemistry/Comité Consultatif pour la Quantité de Matière : Métrologie en Chimie

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

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CCRI	Consultative Committee for Ionizing Radiation/ Comité Consultatif des Rayonnements Ionisants
CCT	Consultative Committee for Thermometry/ Comité Consultatif de Thermométrie
CCTF	Consultative Committee for Time and Frequency/ Comité Consultatif du Temps et des Fréquences
CCU	Consultative Committee for Units/Comité Consultatif des Unités
CEM	Centro Español de Metrología, Madrid (Spain)
CENAM	Centro Nacional de Metrología, Querétaro (Mexico)
CGPM	General Conference on Weights and Measures/ Conférence Générale des Poids et Mesures
CIE	International Commission on Illumination/ Commission Internationale de l'Éclairage
CIPM	International Committee for Weights and Measures/ Comité International des Poids et Mesures
CODATA	Committee on Data for Science and Technology
CPEM	Conference on Precision Electromagnetic Measurements
DI	Designated Institute
EAWG	CCQM Working Group on Electrochemical Analysis
EC	European Commission
EUROMET	European Collaboration in Measurement Standards
GAWG	CCQM Working Group on Gas Analysis
GT-RF	CCEM Working Group on Radiofrequency Quantities/ Groupe de travail du CCEM pour les Grandeurs aux Radiofréquences
IAC	International Avogadro Coordination
IAEA	International Atomic Energy Agency
IAFS	International Association of Forensic Sciences
IAWG	CCQM Working Group on Inorganic Analysis
ICAG	International Comparison of Absolute Gravimeters
IEC	International Electrotechnical Commission
IEN*	Istituto Elettrotecnico Nazionale Galileo Ferraris, Turin (Italy), see INRIM
IERS	International Earth Rotation and Reference Systems Service
IFCC	International Federation of Clinical Chemistry and Laboratory Medicine
ILAC	International Laboratory Accreditation Cooperation

IMEKO	International Measurement Confederation
iMERA	implementing Metrology in the European Research Area, EUROMET project
IMGC*	Istituto di Metrologia G. Colonnetti, Turin (Italy), see INRIM
INMETRO	Instituto Nacional de Metrologia, Normalização e Qualidade Industrial, Rio de Janeiro (Brazil)
INRIM	(the former IEN and IMGC) Istituto Nazionale di Ricerca Metrologica, Turin (Italy)
IOPP	Institute of Physics Publishing, London (United Kingdom)
ISO	International Organization for Standardization
ISO CASCO	International Organization for Standardization, Conformity Assessment Committee
ISO REMCO	International Organization for Standardization, Committee
ITU	International Telecommunication Union
IUPAC	International Union of Pure and Applied Chemistry
IUPAP	International Union of Pure and Applied Physics
JCDCMAS	Joint Committee on Coordination of Assistance to Developing Countries in Metrology, Accreditation and Standardization
JCGM	Joint Committee for Guides in Metrology
JCRB	Joint Committee of the Regional Metrology Organizations and the BIPM
JCTLM	Joint Committee on Traceability in Laboratory Medicine
JILA	Joint Institute for Laboratory Astrophysics, Boulder CO (United States)
KCWG	Key Comparison Working Group
KRISS	Korea Research Institute of Standards and Science, Daejeon (Rep. of Korea)
LGC	Laboratory of the Government Chemist, Teddington (United Kingdom)
LNE	Laboratoire National de Métrologie et d'Essais, Paris (France)
LNE-SYRTE	Laboratoire National de Métrologie et d'Essais, Systèmes de Référence Temps Espace, Paris (France)
MAA	Mutual Acceptance Arrangement
MePWG	CCL Working Group on the <i>Mise en Pratique</i>
METAS	Swiss Federal Office of Metrology, Wabern (Switzerland)
MoU	Memorandum of Understanding

MRA	Mutual Recognition Arrangement
NAB	National Accreditation Body
NEWRAD	New Developments and Applications in Optical Radiometry Conference
NIBSC	National Institute of Biological Standards and Control, Hertfordshire (United Kingdom)
NIST	National Institute of Standards and Technology, Gaithersburg MD (United States)
NMi VSL	Nederlands Meetinstituut, Van Swinden Laboratorium, Delft (Netherlands)
NMI	National Metrology Institute
NMIA	National Measurement Institute, Australia, Lindfield (Australia)
NMIJ	National Metrology Institute of Japan, Tsukuba (Japan)
NPL	National Physical Laboratory, Teddington (United Kingdom)
NRC	National Research Council of Canada, Ottawa (Canada)
NRCCRM	National Research Centre for Certified Reference Materials, Beijing (China)
OAWG	CCQM Working Group on Organic Analysis
OIML	International Organization of Legal Metrology/ Organisation Internationale de Métrologie Légale
PMOD-WRC	World Radiation Centre, Physikalisch-Meteorologisches Observatorium, Davos (Switzerland)
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig and Berlin (Germany)
RAB	Regional Accreditation Body
RMO	Regional Metrology Organization
SAWG	CCQM Working Group on Surface Analysis
SMU	Slovenský Metrologický Ústav/Slovak Institute of Metrology, Bratislava (Slovakia)
SYRTE*	Systèmes de Référence Temps Espace, see LNE-SYRTE
TC	Technical Committee
UNIDO	United Nations Industrial Development Organization
USNO	U.S. Naval Observatory, Washington DC (United States)
VAMAS	Versailles Project on Advanced Materials and Standards
VNIIM	D.I. Mendeleyev Institute for Metrology, Rostekhnregulirovaniye of Russia, St Petersburg (Russian Fed.)



VNIIMS	Russian Research Institute for Metrological Service of Rostekhregulirovaniye of Russia, Moscow (Russian Fed.)
VSL*	Van Swinden Laboratorium, see NMi VSL
WADA	World Anti Doping Agency
WCO	World Customs Organization
WG	Working Group
WGA <sub>v</sub>	CCM Working Group on the Avogadro Constant
WGD	CCM Working Group on Density
WGDM	CCL Working Group on Dimensional Metrology
WGFF	CCM Working Group on Fluid Flow
WGH	CCM Working Group on Hardness
WGHP	CCM Working Group on High Pressures
WGLF	CCEM Working Group on Low-Frequency Quantities
WGLP	CCM Working Group on Low Pressures
WGM	CCM Working Group on Mass Standards
WGMP	CCM Working Group on Medium Pressures
WGRMO	CCEM Working Group for Regional Metrology Organizations Coordination
WHO	World Health Organization
WIPO	World Intellectual Property Organization
WMO	World Meteorological Organization
WTO	World Trade Organization
WTO-TBT	World Trade Organization, Technical Barriers to Trade Committee

## 2 Acronyms for scientific terms

AUV	Acoustics, Ultrasound and Vibration
BMC	Best Measurement Capability
CGS	Centimetre, gram, second system of unit
CMC	Calibration and Measurement Capability
CRM	Certified Reference Material
DNA	Deoxyribonucleic acid
GALILEO	European Navigation Satellite System
GLONASS	Global Navigation Satellite System
GMO	Genetically Modified Organism
GPS	Global Positioning System
GPT	Gas-phase Titration
GUM	Guide to the Expression of Uncertainty in Measurement

ITS-90	International Temperature Scale of 1990
KCDB	BIPM Key Comparison Database
KCRV	Key Comparison Reference Value
MAS	Metrology, Accreditation and Standardization
PLTS-2000	Provisional Low Temperature Scale from 0.9 mK to 1 K
QS	Quality System
SI	International System of Units
SIR	International Reference System for gamma-ray emitting radionuclides
SPRT	Standard Platinum Resistance Thermometer
SQUID	Superconducting Quantum Interference Device
SRP	Standard Resistance Photometer
TAI	International Atomic Time
TWSTFT	Two-way Satellite Time and Frequency Transfer
UTC	Coordinated Universal Time
VIM	International Vocabulary of Basic and General Terms in Metrology
VIML	International Vocabulary of Terms in Legal Metrology
VSMOW	Vienna Standard Mean Ocean Water

STEDI

1, Boulevard Ney, 75018 Paris

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