

**Bureau International des Poids et Mesures**

# **Comité International des Poids et Mesures**

95th meeting (October 2006)

#### 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 AND  
ASSOCIATES OF THE GENERAL CONFERENCE**

as of 10 October 2006

**Member States**

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
CARICOM	Latvia
Chinese Taipei	Lithuania
Costa Rica	Macedonia (the FYR of)
Croatia	Malta
Cuba	Panama
Ecuador	Philippines
Estonia	Slovenia
Hong Kong, China	Ukraine
Jamaica	Viet Nam
Kazakhstan	

## **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.

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

2. The Consultative Committee for Photometry and Radiometry (CCPR), new name given in 1971 to the Consultative Committee for Photometry (CCP) set up in 1933 (between 1930 and 1933 the CCE dealt with matters concerning photometry).
3. The Consultative Committee for Thermometry (CCT), set up in 1937.
4. The Consultative Committee for Length (CCL), new name given in 1997 to the Consultative Committee for the Definition of the Metre (CCDM), set up in 1952.
5. The Consultative Committee for Time and Frequency (CCTF), new name given in 1997 to the Consultative Committee for the Definition of the Second (CCDS) set up in 1956.
6. The Consultative Committee for Ionizing Radiation (CCRI), new name given in 1997 to the Consultative Committee for Standards of Ionizing Radiation (CCEMRI) set up in 1958 (in 1969 this committee established four sections: Section I (X- and  $\gamma$ -rays, electrons), Section II (Measurement of radionuclides), Section III (Neutron measurements), Section IV ( $\alpha$ -energy standards); in 1975 this last section was dissolved and Section II was made responsible for its field of activity).
7. The Consultative Committee for Units (CCU), set up in 1964 (this committee replaced the “Commission for the System of Units” set up by the CIPM in 1954).
8. The Consultative Committee for Mass and Related Quantities (CCM), set up in 1980.
9. The Consultative Committee for Amount of Substance: 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 10 October 2006

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INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES**

on 1 January 2007

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Dr L.F. Vitushkin

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Dr M. Stock<sup>1</sup>  
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*Gardeners:* Mr C. Dias-Nunes, Mr A. Zongo<sup>3</sup>

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

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

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1 Head of special projects.

2 Also Publications.

3 Also site maintenance.

International Committee  
for Weights and Measures

**Proceedings of the sessions  
of the 95th meeting**  
(10 – 13 October 2006)

## Agenda

1. Opening of the meeting; quorum; agenda.
2. Report of the Secretary and activities of the bureau of the CIPM (October 2005– September 2006).
3. Membership of the CIPM and other matters.
4. Report on Resolution 9 of the 22nd CGPM: cross border transport.
5. The CIPM Mutual Recognition Arrangement.
6. The International System of Units, SI.
7. Consultative Committees.
8. Joint Committee for Traceability in Laboratory Medicine.
9. Report from the meeting of NMI directors 2006.
10. CIPM/ILAC Joint Working Group.
11. Materials metrology and the Metre Convention.
12. Contacts with other 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 95th meeting from Tuesday 10 October to Friday 13 October 2006 at the Pavillon de Breteuil, Sèvres.

Present: S. Bennett (present Tuesday, Thursday afternoon and Friday), K. Carneiro, Myung Sai Chung, L. Énard, Gao Jie, E.O. Göbel, F. Hengstberger, B. Inglis, L.K. Issaev, R. Kaarls, S. Leschiutta, J.W. McLaren, G. Moscati, W. Schwitz, H. Semerjian, M. Tanaka, H. Ugur (from Wednesday 11 October), J. Valdés, A.J. Wallard (Director of the BIPM).

Also attending: P. Giacomo and T.J. Quinn (Emeritus Directors of the BIPM); J. Kovalevsky (Honorary Member of the CIPM, present for part of the meeting); I.M. Mills (President of the CCU, present for part of the meeting); B. Perent (Administrator of the BIPM); F. Joly, J.R. Miles (secretariat). Also in attendance for part of the meeting: J.H. Williams (Head of Publications), R. Köhler (Quality Manager and Liaison with ISO and ILAC), and the following Executive Secretaries and contact persons: P.J. Allisy-Roberts, E.F. Arias, R.S. Davis, F. Delahaye, P.I. Espina, R. Felder, C. Michotte, M. Stock, C. Thomas, R.I. Wielgosz, T.J. Witt.

Prof. Göbel, President of the CIPM, opened the 95th meeting by welcoming all present, particularly Dr McLaren, who was attending his first meeting, the Emeritus Directors and the BIPM staff. With nearly all members present (17 out of 18 on Tuesday 10 October), the quorum was satisfied according to Article 12 of the Rules annexed to the Metre Convention.

Prof. Göbel noted with sadness the announcement of the death of Prof. Bray (Italy), member of the CIPM from 1981 to 1991, and the CIPM observed a minute's silence in his memory.

The agenda for the meeting was adopted and the report of the 94th meeting approved. The President noted that the order of various items of the agenda would be changed to ensure sufficient time for discussions on the CGPM.

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 2005 – September 2006)**

All the important matters arising in the report of the Secretary are taken up later in the meeting. Reference is 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 has met on three occasions since the last CIPM. Two meetings were held in March 2006 and October 2006 at the Pavillon de Breteuil in Sèvres and the third was held in July 2006 during the CPEM conference in Turin (Italy). In addition, the Secretary has made several visits to the BIPM and has held a number of discussions with the Director, while the President, the Secretary and the Director met as well twice at the PTB in Braunschweig (Germany).

The bureau also held its regular liaison meetings with the OIML and with ILAC in March 2006.

### **2.2 CIPM membership**

It was with considerable sadness that we were informed of the death of Professor Anthos Bray on 28 June 2006. He was a member of the CIPM from 1981 until 1991, the President of the CCM from 1985, and a distinguished President of the then IMGC\* in Turin (Italy).

During the last twelve months there has been one election to the CIPM. Dr James McLaren, Director General of the INMS NRC in Ottawa

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\* Renamed Istituto Nazionale di Ricerca Metrologica, INRIM.

(Canada) was elected rather soon after the CIPM meeting in October 2005 to replace Dr Janusz Lusztyk of the same Institute as Dr Lusztyk undertook different responsibilities within the NRC and resigned from his membership of the CIPM.

The bureau has also given careful consideration to the long-term composition of the CIPM. Whilst not deviating from the membership criteria agreed by the CIPM at its last meeting, the bureau draws the Committee's attention to the value of electing younger candidates. This helps provide for succession, and helps ensure continuity. It is therefore important to take account of candidates' scientific backgrounds so that there will be appropriately qualified individuals who can take on the role of President of a Consultative Committee. The bureau is well aware that the role of a CIPM member carries considerable responsibility and demands regular contacts with the BIPM during the year and, especially in the case of Presidents of Consultative Committees, a close following of the activities of the relevant Committees.

### **2.3 Member States**

The number of Member States remains at 51.

The BIPM has received official notification that Serbia is the successor to the former Serbia and Montenegro and will stay as a Member State. The Director is following up contacts in Montenegro.

### **2.4 Situation in relation to payments of the BIPM contributions by Member States for 2006**

The BIPM has received 86 % of the dotation at the end of September 2006. Further, the BIPM expects to receive about 86 % of the discretionary contributions.

Of the Member States which still have to pay their 2006 contribution, that of the United States represents nearly 10 % of the annual budget. A recent communication from the US State Department indicated that this was likely to be paid in instalments, the first not being until November 2006 at the earliest. This raises issues of cash flow and has implications for the use of reserves and their level. The bureau has considered the latter and, although discussions at the last CGPM suggested that the level should be of 40 % of

annual budget, the bureau, in the light of several delayed payments and the uncertainty attached to others, believes that 50 % is more appropriate.

## **2.5 Member States in financial arrears**

The bureau has spent a considerable time on the issue of Member States in arrears. The contributions of Member States in arrear of more than three years are redistributed over the other Member States. The bureau noted that the BIPM has been successful in negotiating rescheduling arrangements for two Member States in financial arrears. However, the fact that Member States with more than six years of arrears had not formally been excluded from the Metre Convention in conformity with the article 6 of the Rules annexed to the Metre Convention had led, in general, to the current predicament in which, in many cases, it may be impossible for some of them to repay the full arrears. The bureau also noted that the Metre Convention does not specify a formal process for exclusion and agreed to propose a new policy to the CIPM, and to the CGPM, in the context of Draft Resolution H of the Convocation.

There continue to be four States in arrears for more than three years: Cameroon, the Dominican Republic, the Islamic Republic of Iran and the Democratic People's Republic of Korea.

There have been some contacts with the Democratic People's Republic of Korea and the Dominican Republic but so far these have not led to substantive exchanges. Communications with Cameroon are not answered. The bureau has, however, paid special attention to the discussions between the BIPM and the Government of Iran. Initial contacts between the BIPM and the Iranian Embassy in Paris were made in July 2004 and a proposal was made for the payment of the outstanding arrears. It is noted that most of the arrears of Iran to the BIPM have been distributed over the other Member States and that Iran has indicated that it may be willing to pay at least part of its arrears back. The Embassy made a formal contact in November 2005 which stated the intention of Iran to become, once more, an active member of the Metre Convention. This visit was followed up with a meeting at which a detailed rescheduling plan over 5 years was discussed. In May 2006, the BIPM received a letter from the Iranian Foreign Affairs Ministry which argued that Iran had resigned from the Metre Convention in 1979 and so repayment of arrears since then, was not "in conformity with the rules and regulations of the Islamic Republic of

Iran". The BIPM's response was that Iran had notified in 1979 its "suspension", rather than resignation, and at various other occasions had indicated that they were willing to pay their debts, and that the offer by the BIPM of a rescheduled payment was still open. The Embassy subsequently asked for more information, since when there has been no further contact.

A comparison with the situation between Iran and the OIML is interesting as, after resignation in 1979, they applied for reinstatement in 1996, and rejoined with the payment of their arrears for 1978 and 1979. After that they accumulated arrears of four years in 2001, which should have led to their exclusion. However they repaid them and remain members of the OIML.

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

## **2.6 Associates of the CGPM**

Since the last CIPM, CARICOM became an Associate and signed the CIPM MRA. The number of Associates of the CGPM is therefore 20 in September 2006.

The Directors from NMIs in all 20 Associates have signed the CIPM MRA.

CARICOM represents in the scope of the CIPM MRA 11 countries situated in the Caribbean area.

Current contacts with potential Associates include Moldavia, Tunisia, Morocco, Iraq, Sri Lanka and Bolivia. The BIPM is pursuing contacts with Montenegro after its separation from Serbia.

In reviewing the States which are Associates, the bureau of the CIPM felt that, where possible, they should be pressed to become Member States. It also felt that there should be a regular review by the CIPM of States now being Associates of the CGPM, and that criteria should be set for judging when an Associate should be pressed to transfer to the status of Member State. This is now formulated as Draft Resolution E of the 23rd CGPM. These intentions have also been discussed at the meeting of NMI Directors immediately before the CIPM in October 2006.

## **2.7 Assistance to developing countries and potential new Associates or Member States**

On many occasions, the bureau has discussed how best to respond to the needs expressed by developing countries. These range from a requirement simply for information about the BIPM or the Metre Convention, to requests for attendance at seminars to raise the profile of metrology or to brief senior officials or politicians. In addition, a number of seminars and workshops, arranged within the context of the Joint Committee on coordination of assistance to Developing Countries in Metrology, Accreditation and Standardization (JCDCMAS), would benefit from the contributions of the Metre Convention so as to balance those of other JCDCMAS members. There is also potential, but difficult to quantify, benefits from active marketing of the benefits of signing up as a Member State or an Associate of the CGPM.

The bureau has therefore prepared Draft Resolution G which proposes a category of “Corresponding NMIs of the BIPM”. The aim of this category is to introduce NMIs to the work of the BIPM with the aim of converting this time-limited status to that of Associate and, in due course, from Associate to Member State.

## **2.8 Associate “Economies” of the CGPM**

The bureau has also debated the way in which applications from regional economic cooperations, such as CARICOM, as Associates has been handled. Bearing in mind the technical and possibly political sensitivities in dealing with such groupings, as well as the fact that, at the moment, the admission of Economies as Associates is an automatic process, the bureau prepared Draft Resolution F on this subject.

## **2.9 CIPM papers – approval by correspondence**

During the last year, the Director circulated a number of papers to the CIPM for approval by correspondence. The need for this will continue, particularly in the case of policy papers recommended by the JCRB, so it is important that all members of the CIPM confirm their agreement or, if necessary, ask for additional points to be taken into consideration. In this way, the position of the whole CIPM is clear. In order to avoid any misunderstanding or approval without a qualified majority the Director will

ask all members to acknowledge receipt, through the electronic response request, of any email with a paper for approval by correspondence. The details of the CIPM papers – approval by correspondence will be formulated, after approval by the CIPM, by the Director in a separate document.

## **2.10 BIPM matters**

### **2.10.1 Staff Statute**

The revised Staff Statute, as agreed by the CIPM in 2005 and including the Code of Conduct, came into force on 1 March 2006.

The bureau has discussed an updating of the BIPM Staff Statute, which includes many rules that date back some 40 years, with the Director. This project will begin soon and the results will be presented to the CIPM for approval, probably at its meeting in 2007.

### **2.10.2 Headquarters Agreement**

As recalled during our previous session, the 1969 *Accord de Siège* between the French Government and the CIPM did not provide for all the privileges and immunities needed by the BIPM and its staff. Therefore, an amendment has been, with the approval of the CIPM, negotiated to that end with the French Government, which, after due recommendation from the French *Conseil d'État*, needs now to be approved by the French Parliament. The Amendment should theoretically enter into force within one year.

### **2.10.3 Future of activities previously carried out in the Length section of the BIPM**

Following the Director's presentation to the CIPM in October 2005, the bureau has been closely involved with the assimilation of the former activities of the Length section into the re-named “Time, Frequency and Gravimetry” section. This has gone well. A number of laser-based work items have been stopped and former members of the Length section are now involved to an increasing extent in a number of activities in the Time, Frequency and Gravimetry section. In particular, the combined resources have been instrumental in justifying and helping coordinate NMIs' views on the need to address the issue of how to compare the next generation of

highly accurate clocks when these cannot be moved from their laboratory locations.

The bureau's view is that the BIPM will require internal competences in interferometry and in absolute frequency measurement for the calculable capacitor, the watt balance and for calibrations to be carried out within the international comparison of gravimeters. The ability to perform these at the same time as the comparison of absolute and relative gravimeters is held, gives the BIPM a distinct advantage over other possible sites for this comparison. There are, therefore, benefits to the BIPM's own work from the retention of a number of activities and these will be presented to the CIPM for approval.

#### 2.10.4 Quality System

The Secretary attended the annual management review of the BIPM's Quality System (referred to in the latest version of ISO/IEC 17025:2005 as the "management system").

In the past year regular internal and external audits have taken place although not with the regularity planned as a result of the absence of the Quality Manager on sick leave. These have now been resumed and the manager has returned to work. In overall terms, external audits have been very satisfactory although the lack of resources has led to a management decision to suspend temporarily the internal high-quality calibration service for platinum resistance thermometers. The auditor for the Time section drew attention to the fact that only one member of the section is fully conversant with the software for TAI. The vulnerability of the BIPM in this area is one of the factors that has led to the proposal from the Director to recruit a software specialist as a backup for the section.

Later this year, the Information Technology section and the Chemistry section will be taking the first steps to install the management system in their work.

#### 2.10.5 Staff recruitments

Since the last meeting of the CIPM in October 2005, apart of the three positions mentioned in the 2005 Secretary's report to the CIPM, no further extension of the number of staff has taken place. However, the critical

vulnerability of the BIPM in some areas will require some additional staff, while due to the retirement of senior staff, like section heads, in the next few years, it will be necessary to recruit in advance of these retirements some replacements, so that there would be adequate transfer of knowledge and handover of responsibilities.

#### 2.10.6 Pension fund

The bureau discussed the future position of the pension fund. Several rather early retirements and the fact that people live longer, which contributes to the fact that, before long, the number of retired staff members will reach the number of active staff, the contribution to the Pension fund has to continue to be increased over the coming years. This is in accordance with the decision of the CIPM, in 1994, to increase the annual contribution to the pension fund with an additional 2 % of staff salaries. In order to maintain a long term stable fund the bureau has decided to ask further advice on the continuity and position of the fund as well as on the pension conditions.

#### 2.10.7 Refurbishment of the old workshop and maintenance of buildings

The refurbishment of the old workshop will be finalized in 2006. In the mean time urgent maintenance work will start on the Pavillon de Breteuil and its Grande Salle. Also, needed modifications on some of the laboratory rooms will be realized.

### 2.11 CIPM MRA issues

#### 2.11.1 Policy

The bureau has been associated with a number of issues related to the policy and the implementation of the CIPM MRA. The Director and the Secretary both attend the JCRB so as to help facilitate communication and consistency of approach between it and the CIPM. In particular, the bureau has been involved in discussions concerning:

- A number of CIPM policy documents and their revision. After the CIPM's approval has been received, these are placed on the open part of the BIPM website which is dedicated to the CIPM activity.
- Arrangements for the use of the CIPM MRA logo.

- The approval, by the CIPM, of a process through which RMOs could gain international confidence in the Quality Systems of intergovernmental organizations such as the International Atomic Energy Agency (IAEA). This is through a special meeting or panel which could include RMO Chairs and TC Quality representatives. This process reflected earlier discussions in the JCRB and respected the intergovernmental nature of the first such body, the IAEA, to present its Quality System. This will be reviewed in the light of the outcome of the meeting as there may well be other intergovernmental organizations which will wish to sign the CIPM MRA and so will be required to demonstrate a similar competence.

#### 2.11.2 JCRB

The Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB) met in October 2005 at the BIPM and was hosted by EUROMET in April 2006 at PTB, Berlin (Germany). During those meetings the committee discussed the differences between the terms “Best Measurement Capability” (BMC), used by the accreditation bodies in the scope of the ILAC Arrangement, and “Calibration and Measurement Capability” (CMC), used by the NMIs in the scope of the CIPM MRA, which for years have lead to confusion in the accreditation and metrology communities alike. The joint BIPM/ILAC working group, with representatives from the metrology and accreditation communities, was appointed to resolve the differences and held its first meeting in August 2006 during the NCSLI conference in Nashville, Tennessee (USA). The JCRB in its meeting on 6 October 2006 agreed with the basic concept of a new definition of “Measurement Capability” in the scope of the CIPM MRA, which also should apply in the scope of the ILAC Arrangement. It is expected that the working group will finalize its work in March 2007. A new definition will be submitted for approval to the CIPM.

A new procedure was developed for the review of the quality management systems of intergovernmental organizations which are signatories of the CIPM MRA. The new policy is consistent with the approach used by EUROMET and SIM for the review of their Quality Systems and in agreement with the guidelines given in document [JCRB-10/08\(1c\)](#), and facilitates the Quality System review without compromising the international status of those organizations. The new policy was first used in

October 2006 to review the quality management systems supporting the CMCs of the IAEA in the area of dosimetry.

A logo for the CIPM MRA was introduced and guidelines were developed for its inclusion in the calibration certificates of laboratories participating in the CIPM MRA. As of October 2006, 10 NMIs have requested permission to use of the CIPM MRA logo; a complete list of those laboratories can be found in the CIPM MRA section of the BIPM website.

New criteria were developed for advising RMOs on the selection of peers tasked with visiting laboratories for the purpose of reviewing Quality Systems and/or CMCs. The deadline for the implementation of Quality Systems in the area of chemical metrology went into effect on 31 December 2005. The RMOs were asked to report on their compliance with appropriate Quality System standards and those CMCs not supported by RMO approved Quality Systems will be removed from the KCDB by October 2006.

As a result of a secondment from the PTB Technical Cooperation Division, the JCRB is developing a guide to the implementation of the CIPM MRA. The aim is to summarize, in a single document, the operational aspects of the CIPM MRA process as these are currently contained in a dozen or more documents from the JCRB and the CIPM. It will make use of hyperlinks to provide access to the full text of any policy in question. The document is expected to become available by December 2006.

### 2.11.3 The CIPM MRA database

Appendix B of the CIPM MRA now covers 547 key comparisons and 138 supplementary comparisons. Among these 547 key comparisons, 219 have their final reports approved and posted in the KCDB, providing a total of about 730 graphs of equivalence displayed in the KCDB. The results of 43 RMO key comparisons are published in the KCDB. Linkage has also been carried out for seven bilateral key comparisons subsequent to full-scale Consultative Committee key comparisons; their results are added on the appropriate graphs of equivalence.

On 18 September 2006, 18 436 CMCs were published in Appendix C of the CIPM MRA. Following the decision of the JCRB at its 14th meeting, held in Minsk in May 2005, 723 CMCs that were not covered by an approved

Quality System were deleted from the KCDB in July 2005. Since then, more than 200 of those CMCs have been reinstated.

The number of monthly external connections to the KCDB website was of order 11 100 over the first months of 2006, against 8 600 visits in March 2005. The number of visits to Appendix C has continuously increased since the creation of the KCDB. It is, however, very difficult to identify the visitors, a proportion of more than 70 % come from web providers.

A new page entitled “*KCDB Newsletter – KCDB Statistics*” is available from the KCDB Home page. It gives access to the successive issues of the *KCDB Newsletter* and to some statistics. Especially it displays real-time information on the number of CMCs published by country and by metrology area in Appendix C.

## **2.12 Regional Metrology Organizations**

SADCMET announced the plan for a new Regional Metrology Organization within Africa to be known as AFRIMETS, having five sub-regions of which SADCMET is one of them. It is expected that a change from SADCMET to AFRIMETS will come into effect in time for the 18th JCRB meeting to be held at the NML\* in Pretoria (South Africa) on 4 May 2007. On that occasion, the JCRB also plans to hold a two-day seminar on the practical aspects of participation in the CIPM MRA for metrologists from potential signatory NMIs who are yet to take full advantage of the arrangement.

## **2.13 General Conference on Weights and Measures (CGPM) in 2007**

### **2.13.1 Dates and place of the 23rd CGPM and preparatory activities**

The 23rd CGPM will take place between 12 and 16 November 2007 and will be preceded by a meeting of the CIPM. This is a month later than initially planned as the location normally offered by the French Government (Centre de Conférences Internationales of the French Ministry of Foreign Affairs, Avenue Kléber, Paris) is not available in October and the hire of an alternative location would have involved a considerable expense.

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\* Renamed National Metrology Institute of South Africa, NMISA.

The bureau has been closely involved in the preparation of the documents for the next CGPM. These are presented to the CIPM at this meeting. The Secretary also attended a meeting between the BIPM Director, the Administrator and representatives of the French Foreign Ministry at which the practical arrangements were discussed as well as a number of other issues which related to the Draft Resolutions.

#### 2.13.2 Financial situation of the BIPM

This year, decisions on the BIPM dotation to be proposed are complex. There is no doubt in the bureau's mind that even to "stand still" requires a substantial increment. The reasons include the fact that the reserves have been used to balance the budget and, as planned, to fund the start up costs for chemistry. They cannot be used in a similar way to meet funding shortfalls in the future. Similarly, the bureau has examined the BIPM's running costs and its obligations in regard to expenses such as the staff pension fund, which is consuming an increasing proportion of the annual budget. Maintenance of the buildings cannot be further postponed, so the expenses on building maintenance have to be brought back to the normal level of regular maintenance as has been applied in the past.

Past under-funding of the scientific elements of the workplan has, as the CIPM has warned successive General Conferences, left the BIPM without the financial resources to pay for core requirements, let alone the important and much-needed additional activities proposed in the 2009-2012 workplan. The CIPM will have to provide clear and well-founded arguments for the increases in funding needed to operate the BIPM and to meet the high priority activities presented in the workplan.

### 2.14 Relations with other bodies

#### 2.14.1 International Organization of Legal Metrology (OIML)

The bureau has met with members of the OIML Presidential Council during the annual liaison meeting in March 2006 and with individual members of the OIML from time to time. As a result, the bureau encourages initiatives by the BIPM and the OIML to identify complementary activities with a view to increasing collaboration, and to presenting a more unified face for metrology to the outside world. The Director is presenting a paper to the CIPM on this topic. Any further steps towards "rapprochement" will be

made cautiously and will be built on solid reasons for greater interaction between the two bodies.

#### 2.14.2 International Laboratory Accreditation Cooperation (ILAC)

A positive response had been received to the joint declaration with ILAC and to the tripartite declaration with ILAC and OIML from a few intergovernmental organizations and international bodies. Positive responses had also been made by various Directorates General of the European Commission to whom the President had written.

The bureau has monitored the activities of the joint CIPM/ILAC Working Group, and draws the attention of the CIPM to the increasingly close cooperation and the increasingly common view on matters of interest to the two bodies. Discussions with ILAC on BMC/CMC issues will be reported to the CIPM by the Director. The Secretary and other bureau members attended the second meeting of the Regional Metrology Organizations and the Regional Accreditation Bodies. Whilst progress is at the moment slow, there is great potential for these meetings to help implement the conclusions of the CIPM/ILAC Working Group and to encourage greater regional cooperation and exchange of views.

#### 2.14.3 Relations with other intergovernmental organizations and international bodies

The cooperation with other intergovernmental organizations and international bodies is successfully continuing and in particular through participation in the work of the Consultative Committees steadily increasing. It demonstrates the interest of the other organizations in globally recognized, reliable, comparable and traceable measurements results.

Among the organizations with which recently contacts have been established we call the World Anti Doping Agency (WADA), Pharmacopeia and Forensics associations. The bureau recommends all the Consultative Committees to establish, whenever relevant, links with other international bodies having expertise and interests in metrology.

## 2.15 Joint Committees

### 2.15.1 Joint Committee for Guides in Metrology (JCGM): the VIM and the GUM

The Director will report to the CIPM about progress made by the JCGM and its two working groups on the *International Vocabulary of Metrology* (VIM) and on the *Guide to the Expression of Uncertainty in Measurement* (GUM) under a separate point of the CIPM Agenda. The bureau discussed how the new VIM and, in due course, the GUM supplements will be accepted by the community of NMIs. It decided on an open consultation of all NMIs and the invitation to provide only editorial comments. The deadline for comments on the VIM 3rd edition is 1 November 2006.

### 2.15.2 Joint Committee on coordination of assistance to Developing Countries in Metrology, Accreditation and Standardization (JCDCMAS)

The JCDCMAS increased its coordination efforts, producing a number of publications aimed at creating awareness in the developing world to the needs for a MAS infrastructure. The first document was produced by ISO using input from all members and it is entitled “Metrology, Standardization and Conformity Assessment: building an infrastructure for sustainable development”. The second document was produced by the BIPM for publication in the October 2006 issue of *ISO Focus* magazine and it is entitled “The invisible thin line: quality assurance and well-being of the world”. Both articles are available in electronic form at the new JCDCMAS website ([www.jcdcmas.org](http://www.jcdcmas.org)). The committee will hold a workshop in October 2006, entitled “Effects of the bilateral and regional free trade agreements on the metrology, accreditation and standardization systems”. The workshop is to be held in Lima (Peru) and is to be attended by staff from the metrology, accreditation and standardization agencies in the Andes region. It will be addressed by the BIPM Director.

### 2.15.3 Joint Committee on Traceability in Laboratory Medicine (JCTLM)

The activities of the JCTLM and its two working groups have successfully continued and are operating on the basis of a transparent Quality System.

The process followed by the JCTLM Working Group 1 for the Review of Certified Reference Materials and Reference Procedures of higher order follows the same systematic approach as is being applied under the CIPM MRA. The results are published in the JCTLM database and are accessible through the BIPM website.

The JCTLM Working Group 2 on Reference Measurement Laboratories is now developing a database of reference measurement services offered by the reference measurement laboratories in the field of clinical chemistry and laboratory medicine and organizes a proficiency testing scheme in which listed reference laboratories have to take part.

The industry associations of the *in vitro* diagnostics industries have said that the results of the work under the JCTLM have a high added value and that in particular the JCTLM database is highly used by the industry.

#### **2.16 The International Electrotechnical Commission (IEC) and the decimal marker**

The ISO has confirmed that it accepts and will implement the 22nd CGPM Resolution 10 on the use of the decimal marker. It became apparent, however, that the IEC had not made a similar commitment and that the issue was a live one. The President and the Director therefore sent a joint letter to the IEC asking that they endorse the use of either the point or the comma as the decimal marker, depending on common usage in the language of the relevant documents. The issue was to be discussed at an IEC meeting on 25 September 2006, and we hear that IEC has agreed to use the point and the comma in conformance with the CGPM Resolution.

#### **2.17 Directors' Meeting**

A meeting of directors of NMIs was held on 9-10 October 2006. The meeting focused on the CIPM Report to the 2007 CGPM on "Evolving Needs for Metrology in Trade, Industry and Society and the Role of the BIPM", which is an update of the 2002 Report to the 2003 CGPM, and on the future workplan of the BIPM for the period 2009-2012.

An oral report will be made under item 9.

## 2.18 World Metrology Day

At the occasion of World Metrology Day on the 20th of May the Director has issued his promotional message under the title “A world of metrology at the service of the world”. The message has been well received and used in several countries promoting metrology at national events.

## 2.19 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	2003	2004	2005	2006
I. Ordinary funds	6 796 242.47	6 716 177.48	6 656 826.81	7 405 481.57
II. Pension fund	10 895 038.83	11 240 366.44	11 260 670.61	11 872 421.60
III. Special fund for the improvement of scientific equipment	0.00	0.00	0.00	0.00
IV. Staff loan fund	202 427.33	209 624.60	217 347.38	229 312.25
V. Building reserve fund	0.00	0.00	0.00	365 499.97
VI. <i>Metrologia</i>	0.00	0.00	0.00	0.00
VII. Medical insurance reserve fund	630 883.82	609 069.49	586 449.25	581 222.28
Totals	18 524 592.45	18 775 238.01	18 721 294.05	20 453 937.67

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

Dr Semerjian asked if the IAEA contributed financially to the BIPM. Prof. Wallard confirmed that it did not, and that no provision had been made in the Metre Convention or CIPM MRA for the financial participation of international bodies. However, he pointed out that the IAEA provides free calibrations for a number of Member States, and it would be expensive if the BIPM were to undertake these instead. The bureau of the CIPM had decided it was best to accept the *quid pro quo* situation without introducing fees. Dr Kaarls added that although the JCRB had made remarks about the

efforts required to review the IAEA's quality management system, in fact the extra workload was minimal and had required just an extra half-day's meeting.

Dr Semerjian asked whether this special case would be extended to other intergovernmental organizations in the future, but Dr Kaarls believed the IAEA was an exceptional case in that it has its own laboratories and does not, as might be the case with other intergovernmental organizations, require the designation of external laboratories.

Dr Semerjian then turned to the question of BMCs/CMCs in item 2.11.2 of the report, commenting that there was no confusion in the metrology community, and suggesting that perhaps clarification rather than redefinition of the terms was necessary. Dr Kaarls also pointed out that the metrology community has implemented the terms differently in different fields, and this inconsistency leads to confusion. It is hoped that the efforts of the BIPM/ILAC Working Group on this issue will lead to a new definition that will improve the consistency of its application.

Prof. Gao Jie raised the issue of political sensitivities on the issue of Associates being encouraged to become Member States. Prof. Göbel assured him that the CIPM was well aware that even Associate States may become Member States. A Member State must be internationally recognized. The bureau would continue to check the wording of all documents carefully to ensure that political sensitivities were respected.

Dr Hengstberger commented that AFRIMETS will represent both legal and scientific/industrial metrology, as in COOMET and SIM. This is because, particularly in many developing countries, the legal metrology entity is the *de facto* NMI.

Prof. Göbel thanked the CIPM for their comments and concluded the discussion.

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

Prof. Göbel noted that membership of the CIPM was currently complete, and asked if any members intended to resign in the near future.

Prof. Leschiutta noted that he would be submitting his resignation within a few weeks after the meeting. Prof. Göbel accepted the news with regret, thanking Prof. Leschiutta for his contribution to the International Committee, commenting that he was a competent, warm and friendly member.

Prof. Moscati said he intended to resign soon after the 23rd CGPM (2007).

The CIPM then proceeded to a confidential discussion on possible candidates.

With respect to the position of Director of the BIPM it is noted that the current Director, Prof. Wallard, will retire by the end of 2010 at the occasion of reaching the retirement age of 65. The CIPM decided to announce the vacancy for the post of Director of the BIPM in the beginning of 2007. The candidate, to be appointed as Director of the BIPM by the end of 2010, should become appointed as deputy director (Director designate) well before 2010 in order to guarantee continuity and a smooth transfer of duties.

### **4 REPORT ON RESOLUTION 9 OF THE 22ND CGPM: CROSS BORDER TRANSPORT**

Prof. Wallard informed the Committee that the BIPM's original plan, which had been to approach the World Customs Organization (WCO) together with ISO REMCO and, if possible, ILAC, had had to be revised.

There is common agreement that difficulties with customs clearance are a significant and ongoing problem for the circulation of reference standards and reference materials. The problems mostly arise from the actions of

individual customs officers and are often based on bureaucratic or ill-informed interpretation of national import/export legislation.

However, ISO REMCO has decided not to approach the WCO as there is already a procedure for transportation of goods which the WCO believes is effective. As we understand it, the revised REMCO position is to avoid a defensive response from the WCO.

Prof. Wallard proposed an alternative approach based on Resolution 9 of the 22nd CGPM, pointing out that difficulties with cross-border movement of goods were also experienced by bodies other than the BIPM and NMIs, and that we could probably count on the support of the WHO, the WADA, the US Pharmacopoeia, and the IAEA. He proposed organizing a joint BIPM/WCO workshop to bring together as many interested parties and stakeholders as possible to discuss all aspects of the issue, with the aim of highlighting successful procedures in place, commenting on problems that remain, and developing proposals to improve the current situation.

Prof. Göbel thanked Prof. Wallard for his report; there were no questions from the CIPM.

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

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

Dr Espina, Executive Secretary of the JCRB, gave a presentation on recent activities of the JCRB.

The JCRB met in October 2005 at the BIPM and was hosted by EUROMET in April 2006 at the PTB, Berlin (Germany). During these meetings the JCRB discussed the differences between the terms BMC and CMC and appointed a commission with representatives from the metrology and accreditation communities to resolve the differences. This commission held its first meeting in August 2006 during the NCSLI conference and will continue to work on the wording needed to arrive at a common definition, which should be ready in time for the CIPM meeting in 2007.

A new procedure was developed for the review of the quality management systems of intergovernmental organizations who are signatories of the CIPM MRA; this procedure is consistent with the approach used by the RMOs for the reviews of their Quality Systems and enables the Quality System review without compromising the international status of those organizations. The new policy was first used in October 2006 to review the quality management systems supporting the CMCs of the IAEA in the area of dosimetry.

A new logo for the CIPM MRA was introduced and guidelines developed for its inclusion in the calibration certificates of laboratories participating in the CIPM MRA. A complete list of laboratories that have been granted permission to use the logo can be found in the CIPM MRA section of the BIPM website.

New criteria were developed for advising RMOs on the selection of peers tasked with visiting laboratories for the purpose of reviewing Quality Systems and/or CMCs. The deadline for the implementation of Quality Systems in the area of chemical metrology went into effect on 31 December 2005. The RMOs were asked to report on their compliance with appropriate Quality System standards and those CMCs not supported by RMO-approved Quality Systems will be removed from the KCDB in November 2006.

In collaboration with the PTB's Technical Cooperation section, the BIPM is developing a new guide to the implementation of the CIPM MRA. The document is to summarize the operational aspects of the CIPM MRA process, which are currently described in a large number of documents from the JCRB and the CIPM. The document will make use of hyperlinks to provide access to the full text of the various policy documents in question and should be available by December 2006.

Linked to the 18th JCRB meeting on 4 May 2007 at the NML-CSIR\* in Pretoria (South Africa), the JCRB will hold a two-day seminar on practical aspects of participation in the CIPM MRA, for metrologists from signatory NMIs who do not yet take full advantage of the arrangement.

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

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\* Renamed National Metrology Institute of South Africa, NMISA.

Dr Semerjian remarked that certain JCRB documents had been approved during the year by “electronic voting”, meaning that the document had been distributed by email, with on one occasion only two weeks’ notice, and absence of a response had been interpreted as acceptance. The CIPM agreed that this was not acceptable and the voting should be based on positive responses; sufficient time should be allowed to encourage a positive or negative answer from everyone. The BIPM was asked to develop a procedure for approval of documents by correspondence.

In response to a question from Dr McLaren, Dr Espina confirmed that an intergovernmental organization (IGO) declaring CMCs would follow the same procedure as an NMI; the new policy only concerned the review of the IGO Quality System, not their CMCs. This policy had been agreed by the JCRB and was approved by the CIPM by correspondence in July 2006.

Prof. Göbel asked for clarification on how the CMCs from an IGO would be treated. Dr Espina explained that they would be reviewed first by a panel of experts, then undergo an inter-regional review by the JCRB. He confirmed that CMCs declared by an IGO would pass, as for those of an NMI, though the relevant CC Working Group on CMCs.

In response to a query from Prof. Issaev, Dr Espina noted that all RMOs but COOMET had participated in the recent meeting discussing the review of the IAEA’s Quality Systems.

Dr Quinn welcomed the idea of a guide to the implementation of the CIPM MRA, but cautioned against summarizing and paraphrasing the various CIPM and JCRB texts. Dr Espina confirmed that the texts would be quoted directly where appropriate, and hyperlinks would be made to orient the reader to the original documents. All quotes would be made clear.

## **5.2 Report on the CIPM MRA logo and equivalence statement**

Prof. Wallard reminded the Committee that the idea behind the CIPM MRA logo, for voluntary use on the calibration and measurement certificates issued by authorized institutes, was to draw the attention to the recognition of the validity of those certificates, by users of the CIPM MRA. The logo remains the exclusive property of the BIPM. Guidelines for its use [CIPM/2006-04] were approved by the CIPM by correspondence in June 2006, and are available on the BIPM website along with the list of authorized users (see <http://www.bipm.org/en/cipm-mra/logo/>).

Dr Semerjian asked whether the fields for which use of the CIPM MRA logo was authorized for any NMI were clearly defined. Prof. Wallard replied that the fields were those supported by CMCs published in Appendix C of the CIPM MRA, and the CIPM agreed that an explanatory sentence should be added to the BIPM web page listing the authorized users.

### **5.3 Recommendations for on-site visits by peers and selection criteria for on-site visit peer reviewers**

Prof. Wallard presented recommendations for on-site visits by peers in the case of quality management system reviews and intra- and inter-RMO CMC reviews, as well as procedures for settlement of disputes. It gives criteria for selecting reviewers according to ISO 19011:2002, and describes the scope of on-site visits and the information to include in a peer-review report.

Dr Semerjian asked why the document was needed, recalling that the JCRB had previously agreed not to be too prescriptive. Dr Kaarls concurred that the document was not really needed, and that Quality System reviews naturally varied from region to region. Prof. Wallard pointed out that the document had been produced at the request of the RMOs, and Prof. Göbel advised that although its usefulness might be questioned it did not cause any harm. He asked if the Committee had any other comments.

At the insistence of Dr Semerjian, the CIPM finally agreed that the document should first go back to the JCRB for redrafting with less prescriptive language, then come back to the CIPM.

### **5.4 Participation of intergovernmental organizations and international bodies**

Dr Semerjian expressed concern about the special treatment having been accorded to the IAEA. Prof. Göbel said he was convinced that there had been no special treatment.

Dr Semerjian asked what other rules would have to be added to accommodate other IGOs such as the WMO if they also signed the CIPM MRA. Dr Kaarls repeated that the review of the IAEA CMCs had been handled in the same way as for an NMI.

Prof. Wallard confirmed that the WMO were interested in becoming a signatory to the CIPM MRA, and noted that their main areas of concern were in photometry and radiometry and measurement of ground-based ozone. He foresaw that they would wish to designate laboratories in these fields, and said he would liaise with Dr Schwitz if the WMO wanted to designate the World Radiation Center at Davos (PMOD/WRC), currently designated by METAS.

### **5.5 Report on the KCDB**

The CIPM approved a report on the BIPM key comparison database (KCDB) prepared by Dr Thomas, Coordinator of the KCDB.

The report gave details of the number of comparisons and CMCs listed in Appendices B and C of the CIPM MRA. As of 18 September 2006, Appendix B covered 685 key and supplementary comparisons conducted under the auspices of the CIPM and the regional metrology organizations (RMOs), including 547 key comparisons, 219 of which have had their final reports approved and posted in the KCDB, providing a total of about 730 graphs of equivalence.

At the same date, a total of 18 436 CMCs were published in Appendix C:

- 11 632 in general physics;
- 3 245 in ionizing radiation; and
- 3 559 in chemistry;

representing an increase of about 400 CMCs compared to April 2006.

Statistics on the number of comparisons and CMCs per State are updated regularly and presented on the KCDB and BIPM websites.

The number of monthly external connections to the KCDB website was approximately 11 100 over the first months of 2006, against 8 600 visits in March 2005. The total number of visits per month to Appendix B has remained stable since April 2005 at about 2 300 visits. Appendix B is basically made “by the NMIs for the NMIs”, and it seems that we have now attracted this audience. The number of visits to Appendix C has continuously increased since the creation of the KCDB. It is, however, very difficult to identify the visitors, as more than 70 % come from web providers.

The KCDB continues to be publicized through the distribution of copies of the KCDB leaflet and the presentation of the KCDB website at workshops and congresses. Issues 4 and 5 of the *KCDB Newsletter* were launched in December 2005 and June 2006, respectively.

To increase the visibility of the BIPM web system, and simplify the retrieval of relevant information from Appendix C, especially for industrial users not accustomed to the classifications of services in the various metrology areas, a group composed of three BIPM staff – the webmaster, the IT manager and the KCDB coordinator – have studied the advantages of implementing a search facility that would be able to interpret a text-based inquiry. Several such search engines, all commercially available, were compared, and the BIPM has now purchased such software. This new search engine is now being implemented on the prototype Appendix C, and it appears that direct access to information is greatly facilitated. For example, it is possible to find all CMCs containing a given word and then refine via options proposed in a dynamic way (geographical location, NMIs, chemical materials, fields of physics, etc.). It is hoped that this new search facility will be launched on the public website before the end of 2006.

There were no questions, and the CIPM congratulated Dr Thomas on the good work.

## **6 THE INTERNATIONAL SYSTEM OF UNITS, SI**

### **6.1 SI Brochure**

Prof. Wallard noted that the BIPM had successfully published the 8th edition of the SI Brochure on 20 May 2006. Three thousand copies of the full version had been printed, along with 5000 copies each of the Concise Summary and the pocket version. The Brochure had also been published online on the BIPM website.

From the BIPM's point of view, the publication had been extremely successful. A clear policy on sales has been established, and permission has been granted to translate the brochure into about ten different languages.

Prof. Mills remarked that the potential market was vast, and that the majority of undergraduate scientists would be prepared to pay 1 € for a copy of the Concise Summary. Prof. Wallard encouraged members to promote and market all three editions at the national level. He noted that the NPL was going to distribute a rebranded version of the pocket edition, and the NCSLI had already printed several thousand copies of the Concise Summary for distribution inside their journal *Measure*.

Prof. Issaev informed the Committee that both the Brochure and the Concise Summary had been translated into Russian and were proving very popular. He had also published a Russian translation of the Mills *et al.* article in *Metrologia* 43(3), which had created much debate and stimulated the publication of many more articles. Finally, VNIIMS is also preparing a book on future changes within the SI, to inform the wider community.

## 6.2 Redefinition of SI units

Prof. Wallard presented actions since the last CIPM meeting related to potential redefinitions of some of the SI base units. He recalled that Recommendation 1 (CI-2005) of the CIPM in 2005 invited the Consultative Committees to monitor the results of relevant experiments, to consult with the wider scientific community, and to report back to the CIPM on the implications of changing the definitions. The full reports will be submitted in June 2007, but he listed the various activities that have already taken place or are planned:

- **CCT** in June 2005. Recommendation T 3 (2005) recommended a *mise en pratique* of the definition of the kelvin and enhanced the terms of reference of its Working Group 4 so as to deal with the recommendation of the CCU to consider a redefinition of the kelvin at the CGPM in 2011. The CCT took a special interest in the reports of experiments at NMIs to measure the Boltzmann constant. The initial text for the *mise en pratique* of the definition of the kelvin has been prepared and is now available on the CCT web page. A new task group (TG-SI) was created in response to CIPM Recommendation 1 (CI-

2005) and is to hold its first meeting in October 2006 at the PTB Berlin.

- **CCPR** met in October 2005 and charged its Working Group on Strategic Planning (WG-SP) to discuss possible options for the candela. These could include:
  - removing the candela from the base SI units and treating it as a derived unit as had been suggested by some members of the CCU;
  - considering the possibility of a definition based on counting photons.

The WG-SP will meet for the first time on 22 October 2006 at CENAM. At the time of writing it is unlikely that it will propose any changes for the candela in the immediate future and there is no active discussion about this within the community. The CCPR is strongly in favour of retaining the candela as a base unit.

- **CCEM's** SI Working Group met for the first time on 6 March 2006. It heard technical presentations on the follow-up paper by Mills *et al* (*Metrologia*, 2006, **43**(3), 227-246) concerning the implementation of CIPM Recommendation 1 (CI-2005) and on the status of watt balance and Avogadro constant measurements. It discussed the advantages for the electrical community of defining values of  $e$  and  $h$  and some of the consequences. Defined values of  $e$  and  $h$  would enable today's practical system of electrical measurements, based on conventional values of  $K_{J-90}$  and  $R_{K-90}$ , to be exchanged for one based on true SI units; any possible future physics which may indicate that the relations  $K_J = 2e/h$  and  $R_K = h/e^2$  are not exact could be treated without new changes in the SI. Although  $\mu_0$  would no longer have a fixed value, no resulting significant problems in electromagnetic metrology are anticipated. Presenting a definition of the kilogram based on  $h$  to the general public would be difficult. The group defined its terms of reference and scheduled actions to meet the CIPM's June 2007 deadline. On 13 July, at the CPEM'06, it organized and held a public round table discussion on the proposed changes and reactions to them. The main conclusions were:
  - the appearance of some rapprochement between the views of the mass and electrical metrology communities;
  - universal agreement among the electrical metrologists that  $e$  and  $h$  should be fixed; that the resulting uncertainty in  $\mu_0$  would be of no consequence to them; and

- the apparent willingness of industrial metrologists to accept the small changes that would follow abandoning  $K_{J-90}$  and  $R_{K-90}$ .

A second meeting of the group at CPEM'06 was too brief to produce much progress. However it did result in a subsequent proposal to hold a joint meeting with the analogous CCM working group in January 2007 as well as a one-day colloquium intended to clarify the positions of the two communities and to further examine the scientific consequences of the various proposals.

- **CCQM** has had a first discussion on the possible redefinition of the base units. During the meeting of the CCQM, presentations had been given by Prof. Mills and Prof. de Bièvre. The CCQM will have further discussions during its next meetings.
- **CCM** has also established an *ad hoc* WG on changes to the SI and has set a date (23 March 2007) for a special meeting of the CCM to discuss the issue of the kilogram redefinition.

The outcome of the CCEM round-table discussion held during the CPEM 2006 meeting in Turin (July 2006) is to be published in issue **43(6)** of *Metrologia* (2006).

As requested by the CIPM, the CCU and other Consultative Committees a number of awareness meetings are now beginning to take place. There were, for example, several talks at the NCSLI meeting in August 2006. These set out the general position and also dealt with some of the possibilities in specific areas.

Dr Kaarls noted that the CCQM had discussed the possible changes and had no objections in principle, but would prefer to wait until all the work including the Avogadro project, is consistent.

Prof. Mills requested that the Consultative Committees submit their reports to the CIPM by mid-May 2007, rather than June 2007 as stated in the CIPM Recommendation 1 (CI-2005), so that the CCU could discuss them at their meeting in June 2007.

Dr Valdés asked if consideration was being given to also redefining the second, and Prof. Göbel noted that the President of the CCTF should include a discussion of this in the report from the CCTF. Prof. Wallard added that Draft Resolution I of the 23rd CGPM deals with the *mise en pratique* of the metre and the secondary representations of the second, and

will include an invitation to the CGPM to endorse values of the frequency of a number of optical and microwave radiations.

### 6.3 The International Avogadro Consortium

Dr Tanaka presented a brief report on the progress achieved in the second year of the International Avogadro Consortium. He noted that progress was continuing on schedule. The estimated relative standard uncertainty in  $N_A$  had been  $9 \times 10^{-8}$  in 2005. It was now  $6 \times 10^{-8}$  in 2006 for the lattice parameter, volume, and mass of the Si sphere, and the target uncertainty remained  $2 \times 10^{-8}$  in 2009.

He summarized that the main highlights of the year had been the large-scale production of highly enriched  $^{28}\text{Si}$ , and improvements in the measurement technologies in volume, mass, molar mass, lattice parameter, silica layer, and crystal perfection. Several of these had already been published in the open literature.

Prof. Göbel thanked Dr Tanaka for his report and invited questions. Prof. Issaev asked what subjects would be discussed at the March 2007 meeting of the CCM. Dr Tanaka noted that the meeting would be held as usual at the BIPM, and that the convocation had already been circulated. Discussions would include the results of the Avogadro Consortium and the status of discussions on the redefinition of the kilogram. Prof. Issaev remarked that many people would be interested in attending such a meeting.

Prof. Göbel also remarked that it was hoped that enriched silicon sufficient for a second sphere of enriched silicon would be delivered soon, in which case the consortium would request the next round of financial contributions from the NMIs concerned.

### 6.4 The Working Group “*Unités de base et constantes fondamentales*” of the French Academy of Sciences

Prof. Kovalevsky submitted to the CIPM a report of the Working Group on Base Units and Fundamental Constants of the French Academy of Sciences, noting their input to the general discussion on units from a more theoretical point of view.

The working group had studied the following two possibilities:

- Define electrical units starting from the charge on the positron,  $e$ . The ampere would be defined by the flux of a certain number of charges,  $-e$ , per second.
- Take as the base the Planck charge  $q_p = (2\mathcal{E}_0hc)^{1/2}$ . In this expression,  $c$  and  $h$  are fixed by the definitions of the metre and the kilogram whereas  $\mathcal{E}_0$  is the permittivity of free space which would be thereby fixed.

Prof. Kovalevsky explained that the choice between these two alternatives came down to a choice between two visions of physics:

- $\alpha$  is a property of the vacuum, in which case  $e$  would be chosen as the base for the electrical units. Such a choice would accord with those who predict, in the long term, the most advanced string theory. It should also be noted that in this case the force between two charges or two currents in vacuum would no longer be fixed, and this represents a significant difference from the present system. Finally, this would allow the subsequent fixing of the constants  $R_K$  and  $K_J$ , on the condition of course that the equations that link them to  $e$  and  $h$  be confirmed or completed, which is not the case at present.
- $\alpha$  represents a property of the electron, which justifies the choice of  $q_p$ . In this case,  $\mathcal{E}_0$  and  $Z_0$  are fixed. The constant  $R_K$  being linked in a simple way to  $Z_0$ ,  $Z_0 = 2 \alpha R_K$ , we would directly have its value and the watt balance gives access to  $K_J$  with a very low uncertainty. We note by the way that the values of  $\mu_0$  and  $\epsilon_0$  are already linked in the SI by the relation  $c^2 = 1/\mu_0\epsilon_0$ . Choosing  $q_p$  also fixes the ratio  $\mu_0/\epsilon_0$ , which renders the definitions of the metre and the electrical units coherent.

He noted that there appeared to be no crucial experiment that would allow the choice to be made between these two visions, each of which has supporters within the working group. He then raised a number of practical consequences that he summarized as follows:

- The simplicity of the definition works in favour of  $e$ , since the Planck charge or even the vacuum impedance seem more difficult to explain to the man in the street and to put in legislation than does the charge on the electron.
- The danger of the choice of  $e$  is to be tempted to deduce the values of  $R_K$  and  $K_J$  to the value of the charge of the positron using the simple equations  $R_K = h/e^2$  and  $K_J = 2e/h$  whereas it has not been demonstrated

that there are no corrective terms. While the definition using  $e$  does not presuppose these equations, the temptation to use them will be great.

- The choice of  $q_p$  has the advantage of not modifying the basic hypothesis of the present definition by keeping fixed the values of  $\mu_0$ ,  $\varepsilon_0$  and  $Z_0$ . But of course the wording of the definitions would be changed.
- Taking into account the more esoteric nature of  $q_p$ , it would be preferable to give the definition in terms of the vacuum impedance  $Z_0$ .
- The danger of the choice of  $q_p$  stems from the fact that the charge of the electron would be a quantity to be determined. Its uncertainty would be equal to half that of  $\alpha$ , that is to say of the order of  $10^{-9}$ . But, measurements of voltage are made with relative reproducibilities of  $10^{-10}$  to  $10^{-11}$  and one fears that the electrical community would adopt another conventional value for  $e$  for use with  $K_J$  as is done today when  $K_J$  is known in terms of the SI to only parts in  $10^7$ .

The working group also made the following recommendations:

- If  $e$  should be taken as the base for the new electrical units, it is recommended that the present relations between  $R_K$  and  $K_J$  should not be assumed to be exact.
- In the same way, it is desirable not to proceed to a change in the present definition of the kilogram until the inconsistency between the determinations of the Planck constant  $h$  and the Avogadro number  $N_A$  have been resolved.
- The working group recommends fixing the value of the Boltzmann constant  $k_B$  for the new definition of the kelvin. In any case, regardless of the form of this definition, it must be consistent with the value of 273.16 K for the thermodynamic temperature of the triple point of water with an uncertainty of 0.46 mK.
- With the exception of one member in favour of the *status quo*, the working group recommends a new definition of the mole based on the Avogadro constant  $N_A$  independent of the new definition of the unit of mass.
- Taking account of the current use of the CGS Gaussian system among theoretical physicists, notably because it explicitly includes the symmetries of modern physics and thus gives access to a better physical understanding of electromagnetism, it is desirable that it also

be given in detail in the BIPM SI Brochure and be taught in university courses alongside the SI.

Prof. Göbel thanked Prof. Kovalevsky for the report, commenting that it was a very useful document and the CIPM and the CCs, particularly the CCEM and CCU, should consider it carefully.

He kindly requested the CC Presidents to respect the deadline of mid-May 2007 for submission of their reports, so that they could be considered at the meeting of the CCU. He then reminded the Committee that it had *not* been decided to make the changes in 2011, and requested all members to be careful with their choice of wording to the outside world.

## **7 CONSULTATIVE COMMITTEES**

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

Dr Hengstberger, President of the Consultative Committee for Photometry and Radiometry (CCPR), presented a report on the 18th meeting of the CCPR, held at the BIPM on 25 and 26 October 2005, and associated meetings of the CCPR-WG-CMC, CCPR-WG-KC and CCPR-WG-UV. The CCPR unanimously accepted a Code of Procedure for CCPR Working Groups and Task Groups [[CCPR/05-09](#)] and this document has been published on the open BIPM website. Recent activities of the groups and a newly CCPR Working Group on Strategic Planning (CCPR-WG-SP) were described.

CCPR members supported the initiative to formalize the relationship with the CIE through a CIPM-CIE agreement, and Dr Hengstberger presented a draft version of such an agreement to the CIPM, to whom it had first been circulated in March 2006. The CIPM authorized Dr Hengstberger to circulate it to the CIE for their comments, saying that if the CIE requested only minor changes, the CIPM could approve it by correspondence during the year; otherwise they would discuss it in November 2007.

Discussion of CCPR Recommendation P 1 (2005) was deferred to the agenda item on the Convocation to the CGPM (Draft Resolution J).

Prof. Göbel thanked Dr Hengstberger for his report, and Mr Énard asked if it was normal for the CCPR to define the membership of its working groups. Dr Hengstberger confirmed that membership of the CCPR, as for all other Consultative Committees, was defined by the CIPM, but membership of the working groups was defined by the CC. Dr Kaarls noted that this was in accordance with the CC policy guidance document.

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

Dr Kaarls, President of the Consultative Committee for Amount of Substance (CCQM), presented a report on the 12th meeting of the CCQM, held at the BIPM on 6 and 7 April 2006 and preceded by meetings of the various CCQM working groups.

The CCQM and its seven working groups has, as usual, been very active during the year and continues to attract growing interest from NMIs, Designated Institutes (DIs) and a number of intergovernmental organizations and international bodies.

Its annual meeting in April 2006 at the BIPM provided an important opportunity for all the working groups to meet and to exchange knowledge and experience. For the first time there were representatives of the World Anti Doping Agency and the US Pharmacopeia.

Some 100 key comparisons and 94 pilot studies have now been carried out, are in progress, or are in the planning phase. Many RMOs are now carrying out their own key comparisons as follow ups to the CCQM key comparisons, reflecting the growing interest in reliable, comparable and traceable measurements in the community. RMOs are also organizing supplementary comparisons, in gas analysis and as a way of addressing specific regional needs. One concern of the Committee and the working groups is the need for an adequate number of comparisons to underpin CMC statements. The CCQM is addressing ways of assessing the general competences of NMIs and DIs in addition to using the results of key comparisons.

Dr Kaarls highlighted the results of a number of comparisons and the future plans of the working groups.

He reported on the work of the group set up by the CCQM to advise on the programme of work of the BIPM's Chemistry section. This group, which included the Chairs of the other working groups, representatives of all the RMOs, had sent out a comprehensive questionnaire to NMIs and other interested parties. As a result, the Advisory Group concluded that the BIPM's activities in metrology in chemistry should be dedicated to:

- an extension of the current activities in gas analysis, including ozone and some greenhouse gases, and that they should be dedicated to climate change and air quality;
- an extension of the current activities in organic analysis on the development of primary references (purity of organic compounds), including novel science linked to method development for organic analysis in support of food, healthcare and forensic applications;
- a study on the development and needs in bioanalysis; and
- establishing and maintaining liaison with other intergovernmental and international bodies with an interest in metrology in chemistry as far as this is of interest to the CCQM, the BIPM, and the NMIs.

The Advisory Group concluded that it was premature to start laboratory activities in the field of bioanalysis at the BIPM.

The conclusions of the Advisory Group had been presented to the full CCQM which approved them unanimously.

Summing up the activities of the CCQM working groups, Dr Kaarls drew attention to the activities of the CCQM Working Group on Key Comparisons and CMC Quality Control. This group had reviewed 379 CMCs and the process was working well. However it had observed that different CCQM working groups dealt with the evaluation of the key comparison reference value and its uncertainty in different ways. As a result, the 2007 CCQM meetings will include a workshop on measurement uncertainty calculations with the aim of increasing understanding and awareness and with a view to harmonization of procedures.

Dr Kaarls then turned to the CCQM meeting itself. He reported that there had been a discussion on the possible redefinition of the mole, which concluded that any redefinition would not have direct consequences for metrology in chemistry. The Committee, however, maintained a strong interest in the activities of the Avogadro project and restated its opinion that no redefinition of the kilogram and other base units should be considered

before consistent results had been obtained between watt balance experiments and the x-ray crystal density measurements.

The CCQM had received a number of reports, including those from:

- the JCTLM, which had highlighted the importance of its programme of comparisons and the need for NMIs to take part in them so as to be in a position to disseminate traceability to routine laboratories in the area;
- the WADA which had been involved in a successful CCQM study comparison of nandrolone measurements by a number of NMIs;
- the results of a presentation to the Bioanalysis Working Group by the US Pharmacopeia, which, he hopes, will lead to further collaboration;
- the ISO REMCO committee, as a result of which the CCQM called for a consistent definition of “reference material” and “certified reference material” between the ISO REMCO definitions and the current draft of the VIM.

Dr Kaarls also reported on his contacts with the International Association of Forensic Science Institutes and the Codex Alimentarius Commission together with its Inter-Agency meeting.

The CCQM working groups will meet twice before the next CIPM – in Beijing and in Korea during October 2006, and during the plenary CCQM meetings in April 2007.

Finally Dr Kaarls invited the CIPM to discuss Recommendation Q 1 (2006) of the CCQM on metrology in chemistry and biotechnology.

Prof. Issaev drew attention to the discrepancy between the ISO REMCO and the (proposed) VIM definitions of certified reference material, asking the CCQM’s view on which definition should be adopted for the translation of CIPM documents into other languages.

Dr Kaarls replied that the CCQM tended to lean more towards the ISO REMCO definition, and pointed out that the ISO REMCO group were the experts in practical measurements in the field. Dr Wielgosz added that the ISO Guide 35 had been revised and published in 2005, so in the short-term the only way to get harmony between the two definitions was to modify the VIM definition.

Prof. Issaev mentioned that the revised version of ISO Guide 35 had already been translated, and that the policy in Russia was to try to use

work-arounds such as “reference substance” instead of “reference material”. Prof. Göbel noted that the translation was a national issue, but agreed that the BIPM should ask the VIM WG to find harmony with the ISO REMCO definition.

Dr Quinn expressed concern about the large number of key comparisons being undertaken, and encouraged the CIPM to issue a statement on the objectives of the CIPM MRA, reminding participants that the objective was to increase mutual confidence in their measurements, not to support all CMCs with a key comparison. Dr Kaarls replied that the CCQM were well aware that they could not run key comparisons on all measurands and all techniques. Dr McLaren agreed that the CCQM and its working groups were all very aware of the danger of overloading the system. He noted that for the many NMIs establishing activity in the chemical area, some key comparisons were essential in order to be able to review their CMCs. However, strategic planning was essential.

Dr Inglis remarked that the need for “out-of-step” comparisons had been foreseen in the setting up of bilateral comparisons. Dr Kaarls explained that most chemical key comparisons required a well-characterized sample to be distributed at the global level. He noted that RMO activities in the field of amount of substance were very limited. Dr Carneiro expressed his full support for the CCQM’s programme, and reminded the Committee that the CIPM MRA was based on the scrutiny of CMCs and the review of the laboratory’s Quality System in addition to its performance in key comparisons. He noted that if the first two were completed satisfactorily, then the results obtained in a key comparison represented just a third leg of support.

Dr Semerjian commented that concern about the number of key comparisons was not just an issue for the CCQM, and that the worst case was in the CCL. He supported Dr Quinn’s suggestion that the CIPM should restate and re-emphasize the aims of the CIPM MRA. In response to Dr McLaren’s comment on the many new laboratories being established, he expressed concern that many of them wanted to declare CMCs before they were ready, and that the CCQM pilot studies ended up being tutorials. He commented that the CCQM should not spend its time helping these new laboratories.

Dr Schwitz commented that it was difficult to find the correct number of key comparisons, but remarked that key comparisons were an important activity of the CCs.

Prof. Göbel noted that there was general consensus that the CIPM should issue a statement and asked if it should take the form of a Recommendation. Prof. Ugur and Dr Inglis expressed preference for a paragraph in the minutes rather than a formal Recommendation. Prof. Göbel agreed and the CIPM therefore strongly urges Consultative Committees to ensure that key comparisons are only initiated where there is a clear need to support the key techniques in the field, and to identify which CMCs could be supported by these comparisons. Prof. Wallard added that a note in the minutes could reinforce the policy on comparisons stated in the CC policy.

Finally, the CIPM approved CCQM Recommendation Q 1 (2006).

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

Prof. Leschiutta, President of the Consultative Committee for Time and Frequency (CCTF), presented a brief report on the 17th meeting of the CCTF, held at the BIPM on 14 and 15 September 2006 and preceded by meetings of representatives of the TAI laboratories, and the Joint CCL/CCTF Working Group on Secondary Representations of the Second.

The CIPM approved CCTF Recommendations 1, 3, 4 and 5, adopted CCTF Recommendations 2 and 6 as CIPM Recommendation 1 (CI-2006) and Recommendation 2 (CI-2006), respectively. Recommendation CCTF 1 (2006) concerns the establishment of a single CCL-CCTF frequency standards working group, which has been approved by the CCL at its 12th meeting in 2005.

### **7.4 Consultative Committee for Acoustics, Ultrasound and Vibration**

Dr Valdés, President of the Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV), presented a brief report on the 5th meeting of the CCAUV, held at the BIPM on 25 and 26 September 2006.

He commented that the meeting had been friendly and productive, and thanked Dr Allisy-Roberts, Executive Secretary of the CCAUV, for her assistance.

He reminded the Committee that many CMCs were based on frequencies, and called again for frequency measurements to support CMCs, adding that perhaps the comb system at the BIPM could be used to provide validation of frequency measurements. Prof. Göbel called on the CCTF to discuss this, and invited questions on the report.

Prof. Issaev asked if the WHO were participating in the CCAUV activities, pointing out the importance of acoustics for health. He also mentioned the International Labour Organization (ILO), saying they might be interested in safety aspects of the work. Dr Valdés thanked him for the suggestions and Prof. Göbel turned to the report of the CCRI.

#### **7.5 Consultative Committee for Ionizing Radiation**

Prof. Moscati, President of the Consultative Committee for Ionizing Radiation (CCRI), presented a brief report on the activities of the CCRI since 2005.

In response to a question from Prof. Issaev, Prof. Moscati confirmed that the CCRI fully supported the proposed linear accelerator programme for the BIPM.

#### **7.6 Consultative Committee for Length**

Dr Chung, President of the Consultative Committee for Length (CCL), presented a brief report on CCL RMO key comparisons, including responses to a number of specific concerns raised by the CIPM.

Dr Kaarls reminded the Committee that their first concern, on why the gauge block comparisons warranted a different approach from other artefact-based comparisons, had been triggered by questions about the large number of comparisons being organized, especially in the regions. In some ways, the CCL situation was similar to that of the CCQM – but the choice of key comparisons undertaken was supposed to test competence in certain selected areas in order to give confidence more generally.

Dr Quinn agreed, adding that these discussions in the CCL had been going on for a long time. If the artefact was too unstable, then there would be no point in holding the key comparison. As gauge blocks are not that unstable, he suggested that the results could be put on a common graph by assuming that the CCL members behave similarly.

Dr Thomas explained that results of the initial CCL-K1 and RMO-K1 comparisons on gauge blocks had been published in the KCDB with the usual graphs of equivalence, but without linking between them. The new CCL RMO comparisons were being published as stand-alone comparisons.

Dr Carneiro commented that it was interesting to see such problems being encountered in one of the simplest types of measurements. He noted that the major stumbling blocks were what was meant by “key comparison” and what offsets could be assumed between different comparisons. He pointed out that in theory the comparison could equally well be run by sending nominally different gauge blocks to the various participants.

Dr McLaren asked whether what was proposed was really different from the CCQM comparisons, where nominally identical samples are distributed to all participants. Dr Quinn commented that the difference here was that the gauge block itself changed during the course of the comparison. This problem is unique to the dimensional metrology field, but if it is assumed that the most competent laboratories agree, then the linking could be made based on the long-term stability of the performance of these laboratories. When this stability needed to be checked again in the future, another CCL comparison would have to be held.

Dr Schwitz asked if the CIPM accepted that the CCL should only hold CCL RMO comparisons. Prof. Göbel pointed out that their current CCL RMO comparisons were based on the existing CCL comparison, which would have to be repeated in due course.

Prof. Issaev remarked that most comparisons should be held at the regional level, and it was the duty of the CCL to decide which comparisons must be held at the highest level. Prof. Göbel agreed that the CCL should discuss the matter, and noted the general consensus that zero offset could be assumed.

Dr Thomas suggested that for CCL-K1, which had already been completed and published, the graphs should not be redrawn but a sentence could be added to explain the linking between the comparisons. She suggested that

the sentence be drawn up in conjunction with the CCL WG chairmen. It was also suggested that for future comparisons the linking be included as part of the protocol.

Dr Carneiro commented that there were many schools of thought in calculating reference values, and encouraged participants to be open-minded.

Dr Kaarls objected to the assumption that the CCL RMO comparisons were based on the old CCL-K1 comparison, saying that the fundamental problem was that the key comparison did not test the competence of the NMIs. Dr Semerjian agreed that the issue was very unclear, adding that if the CIPM were confused then the external community had little chance of understanding it.

Dr Quinn repeated that credit could be given to the competence of the principal NMIs, and that the problem was one of gauge block metrology. Dr Inglis added that the capability of a laboratory in interferometry was not related to the stability of an artefact. Dr Schwitz remarked that the question of stability could easily be resolved by adopting a star formation for the comparisons, in which the pilot laboratory monitored the condition of the gauge block between each participant; Prof. Göbel welcomed this suggestion.

Prof. Wallard called for the WGDM, which tended to be rather independent, to meet more often on-site at the BIPM. He suggested that the CIPM ask the CCL to develop a paper on the limitations of gauge-block comparisons and the consequences for linkages.

Prof. Göbel thanked the various members for their comments and asked Dr Chung to transmit the CIPM message that they were not completely satisfied with the WGDM responses; he requested a self-standing document from the CCL on how future comparisons would be organized.

## **7.7 Consultative Committee for Units**

Prof. Mills, President of the Consultative Committee for Units (CCU) reported on the activities of the CCU during the year, including in particular the publication of the 8th edition of the SI Brochure, along with the new Concise Summary and pocket version formats, and considerations of how the SI might be revised in the years to come, as discussed at the 94th meeting of the CIPM.

The SI Brochure was dealt with under item 6.1 of the Agenda. Prof. Mills expressed his thanks to all who had contributed to the production of the new editions, noting in particular the members of the CCU as well as many members of the BIPM staff.

On the possible future redefinitions of some of the base units of the SI, he informed the CIPM that he and four co-authors had published a paper in *Metrologia* proposing an approach to the implementation of CIPM Recommendation 1 (CI-2005) (see *Metrologia*, 2006, **43**, 227-246).

The proposed changes require the best possible determinations of the fundamental constants involved (the Planck constant  $h$ , elementary charge  $e$ , Boltzmann constant  $k_B$ , and Avogadro constant  $N_A$ ) so that the new definitions can be made consistent with the definitions that they replace. He noted the importance of new experiments, planned or currently under way, to determine better values of the fundamental constants, and anticipated that the discrepancy between the best estimates of  $h$  (from watt balance measurements) and  $N_A$  (from x-ray crystal density measurements), which are related through the theoretical expression for the Rydberg constant  $R_\infty$ , would be resolved within the next few years. He pointed out that these new experiments would become part of the *mise en pratique* of any new definitions adopted, and noted his personal interest in the current work in radiation thermometry.

Prof. Mills also expressed his admiration of the BIPM watt balance, which he had visited during the laboratory tour the previous day, saying he hoped its funding would continue and increase.

Prof. Göbel thanked Prof. Mills for his report and the CCU for their work, particularly on the new edition of the SI Brochure.

## 7.8 Consultative Committee for Thermometry

Prof. Ugur, President of the Consultative Committee for Thermometry (CCT), reported on the activities of the thermometry community, noting that at present very few NMIs had, or were willing to develop, a programme to determine the Boltzmann constant. He was trying to encourage universities to do so, and a two-day kick-off workshop would be held at the PTB the following week. Further meetings were planned in 2007, 2008 and 2009, and it was hoped that a new result would be obtained by 2010.

Issues related to the future redefinition of the kelvin had taken priority over revising the ITS-90, although almost all clients had expressed concern about the ITS-90 during a recent meeting.

Prof. Ugur expressed his personal view that progress in radiation thermometry could provide both a definition and a *mise en pratique*; he relied on the chairmen of the relevant CCT working groups to keep him informed.

In response to a question from Prof. Göbel, Prof. Ugur confirmed that most of the problems relating to CCT key comparisons had now been resolved and he was very satisfied with the Chairmen of the CCT working groups. He commented that some difficulties remained with the linkage of RMO key comparisons, and he encouraged the BIPM to send representatives to meetings held at external laboratories.

#### **7.9 Consultative Committee for Mass and related quantities**

Dr Tanaka, President of the Consultative Committee for Mass and related quantities (CCM), commented that the CCM did not yet have a Working Group on Strategic Planning. This would be discussed at the meeting of the CCM working group chairmen in 2007.

Dr Davis reminded the CIPM of the revised CIPM formula for the density of moist air, proposed in 2005, publication of which is still pending receipt of the LNE results on argon. Dr Énard said that a report had been published on the determination of argon concentration in ambient air for calculation of air density (*Revue française de métrologie*, No. 8 (vol. 2006-4), 45-51). Two other reports on this subject have also been accepted for publication in *Metrologia*.

The CIPM agreed that Dr Tanaka and the CIPM bureau could authorize publication of the revised CIPM formula when the LNE results were finally published. Mr Énard commented that he had a meeting with the LNE team the following week, and would enquire after progress.

#### **7.10 Consultative Committee for Electricity and Magnetism**

Dr Inglis, President of the Consultative Committee for Electricity and Magnetism (CCEM), confirmed that he would prepare a short written report to describe the activities of the CCEM's seven working groups.

On behalf of the CIPM and as former President of the CCEM, Prof. Göbel expressed his thanks to Dr Tom Witt, who will retire from the BIPM in June 2007, for his long years of work as Executive Secretary of the CCEM. He commented that it had been a pleasure to work with Dr Witt, and wished him well for his retirement.

### 7.11 General rules and policy

Prof. Wallard presented an update of the previously approved CIPM policy paper to deal with the special case of the Consultative Committee for Units (CCU). The CCU differs from other Committees in that its members are a mixture of NMIs, individuals, and international or similar organizations. In nearly all other Consultative Committees, international bodies are invited as observers or individual NMI members, who are involved in the work of an international body, act as a liaison person.

Dr Kaarls commented that the situation was not unique to the CCU, but was also seen in the CCQM, of which the IAEA was a member, as were the IUPAC, IFCC and ISO REMCO.

The revised document was approved without further discussion.

### 7.12 Consultative Committee membership

The following changes were approved:

CCAUV	LNEC (Portugal), previously observer, no longer participates.
CCPR	SPRING Singapore (Singapore), previously observer, becomes a member.
	UME (Turkey), previously observer, becomes a member.
CCT	CEM (Spain), previously observer, becomes a member.
CCTF	Space Research Centre (Poland), previously observer, becomes a member.
	International GNSS Service (IGS) becomes a member.
CCU	CODATA Task Group on Fundamental Physical Constants becomes a member.

### **7.13 Future meetings**

#### **2007**

CCEM 15-16 March

CCM 23 March

CCQM 19-20 April

CCRI 31 May (preceded by the associated meetings of its sections)

CCU 11-13 June

CCPR 21-22 June (preceded by meetings of its working groups)

CCL 13-14 September (preceded by meetings of its working groups)

CIPM 7-9 November

CGPM 12-16 November

Meetings of the CCAUV, CCM, CCQM, CCT, and CCTF were provisionally scheduled for 2008 as follows: the CCQM in April, the CCT during the first week of May, the CCAUV just before the CIPM, and the CCTF towards the end of the year.

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

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

The 4th meeting of the JCTLM Executive Committee was held at the BIPM on 14 November 2005, and was followed by a meeting of the full JCTLM and a symposium entitled "Standardization Activities of Member Organizations and Observers". Prof. J.-C. Forest (IFCC) replaced Prof. J. Thijssen (IFCC) as Chairman of the JCTLM, and the committee confirmed the BIPM's role in continuing to maintain the committee's secretariat.

The activities of the two JCTLM working groups have continued, and quality manuals describing the processes used by both groups were published on the JCTLM/BIPM website in early 2006.

JCTLM WG 1 (Reference Materials and Reference Measurement Procedures) has completed two review cycles of materials and procedures, resulting in the publication of 190 entries for reference materials of higher order and 121 entries for reference measurement procedures within the JCTLM lists. A further 23 entries for reference materials of higher order have been removed from the JCTLM lists, due to either the non-availability of the material, or the expiry date of a material having been reached.

The WG 1 Cycle III review process started in January 2006, and has resulted in 25 nominations of reference materials and 40 nominations of reference measurement methods, which will be reviewed by December 2006.

JCTLM WG 2 (Reference Measurement Laboratories) is currently in the process of reviewing nominations from its first call for reference measurement services offered by reference measurement laboratories. A total of 210 nominations of reference measurement services from 26 laboratories were received in 2006. Only one of the laboratories is an NMI, the other laboratories being linked to hospitals, EQAS providers, or manufacturers. The review process is expected to be completed by January 2007.

Reviews of nominations have been carried out by twelve review teams, with each review team containing on average six members. Members of the review teams are specialists in the clinical chemistry/laboratory medicine field under review, and are volunteers receiving no reimbursement from the JCTLM for their activities in support of the committee. 25 % of the review team members are from NMIs, the majority of the rest are from the *in vitro* diagnostic (IVD) industry. Work within the review teams is carried out by email and telephone communication. Working group meetings are generally held twice a year, and are attended by the review team leaders, to harmonize and report back on the review process.

The next meeting of JCTLM WG1 and WG2 will be held at the LGC (UK) from 15-17 November 2006.

The BIPM has continued to support the JCTLM by serving as the secretariat for the committee, including support of the nomination processes

for JCTLM WG1 and WG2, and the development of a web searchable JCTLM database. Dr R. Wielgosz (BIPM) acts as Executive Secretary to the committee, and Dr S. Maniguet (BIPM) is responsible for developing and maintaining the JCTLM database. Dr Maniguet currently spends 50 % of her time on JCTLM database activities. The JCTLM database is being developed by an external contractor. A prototype database will be delivered to the BIPM in October 2006, and delivery of the final version of the database is expected by December 2006. A project to extend the JCTLM database to include reference measurement services will start in December 2006.

A meeting with representatives of DG Enterprise (responsible for the drafting of the IVD directive with the EC structure) is tentatively scheduled for 30 November 2006, and is being organized through the Institute for Reference Materials and Measurements (IRMM). No official recognition has yet been given by the EC to the results of JCTLM activities, and it is not yet clear which process the EC could use to do this.

Funding of the activities of the JCTLM Secretariat has been met by the BIPM and the IFCC. In 2006 the IFCC contributed 80 000 € to the BIPM to support JCTLM Secretariat activities. Following a request from the IFCC, the JCTLM Secretariat will prepare a budget for expected expenditure for the next five years. Major costs to be considered in the budget will include BIPM staff time devoted to JCTLM activities, and the development and maintenance of the JCTLM database. The funding of JCTLM activities will be discussed at the next JCTLM meeting in December 2006. In addition to the funding of the JCTLM secretariat, the reimbursement of expenses for attending JCTLM meetings would be addressed.

Prof. Göbel thanked Dr Wielgosz for his report and asked why the WHO was not fully participating in the JCTLM. Dr Wielgosz explained that the WHO published lists of reference materials they endorsed based on their own criteria, and they had decided not to submit these materials for review by the JCTLM.

In response to a question from Dr Semerjian, Dr Wielgosz commented that only the IFCC and the BIPM contributed to the funding of the JCTLM Secretariat, and there was currently no contribution from ILAC. No funds were available for travel or accommodation expenses for participants in JCTLM activities. Dr Semerjian accepted that the BIPM should not be funding travel and accommodation costs of committee members.

Prof. Wallard confirmed that this was the case, and the CIPM agreed that funds from Member States should not be used to cover the costs of individuals attending JCTLM meetings.

## **9 REPORT FROM THE MEETING OF NMI DIRECTORS 2006**

Prof. Wallard reported that the Directors' meeting had been held immediately before the CIPM (all-day on 9 October and the morning of 10 October 2006). It had been a successful event at which he had briefed Directors on the proposed BIPM work programme for the 23rd CGPM and at which Prof. Göbel had updated Directors on the current state of the work related to potential redefinitions of the SI base units. Dr Kaarls had given an overview of his 2007 update report on "Evolving Needs for Metrology in Trade, Industry and Society and the Role of the BIPM", which is being prepared on behalf of the 23rd CGPM.

## **10 CIPM/ILAC JOINT WORKING GROUP**

Prof. Wallard noted that the BIPM continues to collaborate closely with ILAC. In particular, a joint declaration with ILAC has been published on the relationship between NMIs and national accreditation bodies (NABs) and another declaration, jointly with ILAC and the OIML, issued on the value of MRAs. Both declarations are available on the BIPM website.

He informed the Committee that discussions continued on the definitions of CMC and BMC (calibration and measurement capability and best measurement capability). He presented the current situation and said that no action was required from the CIPM at present; he would inform the Committee of progress in due course.

The report also mentioned various new initiatives such as meetings of RMOs and RABs. Two such meetings have now taken place and promise to be useful occasions at which to monitor how the RMOs and RABs follow up the high-level commitments made by the CIPM/ILAC Joint Working Group.

The report concluded that collaboration between the CIPM and ILAC is becoming stronger, with ILAC increasingly following the JCRB and other policies as far as traceability and uncertainty is concerned. ILAC's involvement in other committees such as JCTLM, JCGM, and JCDCMAS brings benefits to the BIPM and to the CIPM committee work, and we increasingly share similar views in relation to the writing and implementation of ISO and other standards.

Prof. Göbel thanked Prof. Wallard for his report and invited questions. Dr Schwitz pointed out that NMI services may be accredited but that NMIs themselves are not.

## 11 MATERIALS METROLOGY AND THE METRE CONVENTION

Dr Bennett presented a report from the CIPM *ad hoc* Working Group on Metrology of Materials, established at their 2005 meeting, and of which he is chairman. The terms of reference of the group are as follows:

- to identify those material properties for which globally comparable, traceable measurement results are important for science, engineering and manufacturing technology;
- to identify those material properties for which the needs for traceable measurements are not covered by the activities of the Consultative Committees;
- to establish the user needs for activity in materials metrology;

- to investigate the existing capabilities of participating NMIs by initiating some pilot studies, including a small number of interlaboratory comparisons;
- to develop tools and methodologies for establishing traceability in materials testing;
- to define the objectives, aims and initial activities for an ongoing programme in metrology for materials, including recommendations for underpinning activities, such as the organization of key comparisons and the development of reference materials and reference methods;
- to liaise closely with other interested organizations; and
- to report its conclusions to the CIPM by November 2007.

He reported that the *ad hoc* working group has been established with experts from NMIs and other institutes in some ten countries. The first meeting of the group, at NPL in May 2006, began by addressing the clauses of its terms of reference. Following a discussion of the materials properties which are important for science and manufacturing, the working group explored some of the issues associated with establishing traceability to appropriate standards. To the list of obvious properties (mechanical, electrical and thermal coefficients of solids) were quickly added a number of properties of liquids and the distinctive properties of materials on the nano-scale. One product of this discussion was the following inventory of materials properties (in no particular order):

- structural measurements – grain size;
- dielectric properties;
- powders – size distribution, surface properties, shape, density;
- agreed data for use in modelling;
- thermodynamic properties – conductivity, heat transfer, phase analysis, expansion, heat capacity, emissivity, diffusivity;
- density of porous materials;
- mechanical properties – strength, hardness, Young's modulus, creep, toughness, impact;
- magnetic and optical properties;
- wear, friction, lubrication and corrosion;

- thin films – adhesion;
- nano-structured materials;
- multi-phased materials – composites, aerosols, gels;
- properties of fluids – viscosity, density, calorific value.

The working group decided to establish five Task Groups, as follows:

- 1) Mechanical properties (*Bryan Roebuck – NPL*)
- 2) Thermophysical properties (*Tetsuya Baba – NMIJ*)
- 3) Composition and micro-structural properties (*Richard Kayser – NIST*)
- 4) Functional properties (*Graham Sims – NPL*)
- 5) Electrochemical properties (*Jürgen Lexow – BAM*)

No experimental studies or comparisons are planned at this stage, as the working group decided it was more important to concentrate on collecting information about previous exercises and to study existing provisions for traceability when materials properties are being measured in testing laboratories and elsewhere. The Group recognised that in some cases traceability may be to a standard or a procedure, rather than to the SI in the generally accepted sense, and that the reliability, repeatability and reproducibility of results will be affected by a number of factors. There is also a need to seek the views of the user community in order to identify those properties for which repeatability and comparability are particular problems.

A key question is to differentiate between intrinsic properties of materials and other parameters related to the form and scale of a specimen. Thus thermal expansion or Young's modulus are quite clearly intrinsic properties, while surface finish or particle size describe individual samples and may effect the results of measurements of properties. The use of standardized measurement procedures, as for hardness, creates a repeatability which depends on careful adherence to the accepted measurement sequence and a form of traceability when everyone uses the same procedure. Separating the properties of materials from the factors and problems which influence the results of measurements is seen as an important task to be undertaken by the working group before they can identify the genuine traceability issues which will form the core of their final report.

The working group will meet again in December 2006 at NIST. Meanwhile, as well as collecting historical data about previous international comparisons and identifying issues associated with specification standards and measurement procedures the working group is obtaining views and information from the user community. Contacts have been established with OIML, ISO and ILAC. In addition, a paper was presented at NCSLI this year, requesting input from those with an interest in and experience of the measurement of materials properties. Following the December meeting, the working group will undertake further work, possibly including some very limited pilot intercomparisons, before preparing its report for the CIPM meeting in November 2007. It is expected that this report will include recommendations for new initiatives to improve the comparability and traceability of the measurement of materials properties worldwide.

Prof. Göbel thanked Dr Bennett for his report, and asked if the working group was considering the difference between metrology and testing. Dr Bennett replied that many properties of materials were expressed in SI units, and the group was addressing the traceability to these units. Chairmen of Consultative Committees were asked to send Dr Bennett information on relevant activities.

Prof. Ugur expressed concern that the work of Working Group 2 on Thermophysical Properties would overlap significantly with that of CCT Working Group 9, and pointed out that the two groups shared the same chairman. Dr Bennett reminded him that the Working Group on Materials was an *ad hoc* group that would run for just one more year. It might recommend strengthening the CC WG, but there was no need to consider merging the two groups at present.

Dr Kaarls asked if there was not a danger that some issues would be tackled from two different sides, but Prof. Göbel did not see this as a problem. The working group would report back in 2007, and the CIPM would then analyse what should be done.

Dr Tanaka mentioned that in fluid metrology many different databases existed, and the traceability of the data in these databases had to be established.

At the request of Dr Valdés, who wished to send some of the material to the CCAUV members for information, Dr Bennett agreed to circulate his PowerPoint presentation to the CC Presidents.

Prof. Göbel thanked Dr Bennett for his report and the work undertaken, and reminded CC Presidents if they had not already done so to send Dr Bennett information on relevant CC activities in the field of materials metrology.

## 12 CONTACTS WITH OTHER ORGANIZATIONS

Prof. Wallard remarked that contacts between the BIPM and other international bodies was an important part of the BIPM's work, involving three or four man years of effort per year. An internal BIPM document detailed the BIPM's strategies for dealing with each organization, and he listed the following examples of current interactions.

**WMO:** The WMO has expressed interest in becoming a signatory to the CIPM MRA, and a joint BIPM/WMO conference on metrology in climate change will be organized in 2008.

**WTO:** This was discussed elsewhere (under item 15.4: Draft Resolution D).

**Codex Alimentarius and WADA:** Relations are being built up and a number of CCQM comparisons have dealt with topics of interest to these bodies.

**US Pharmacopeia:** Representatives from the US Pharmacopeia visited the BIPM on 27 July 2006 and a similar visit should be organized with the European Pharmacopeia. A follow-up visit by BIPM staff to the US Pharmacopeia will be organized.

**UNIDO:** The possibility of a Memorandum of Understanding between the BIPM and UNIDO was being explored, and it is hoped that a text can be presented to the CIPM in 2007.

**CIE:** This was discussed earlier (agenda point 7.1).

**JCDCMAS:** Prof. Wallard drew attention on the activities of this Joint Committee, currently under the secretariat of UNIDO. The JCDCMAS has increased its coordination efforts, producing a number of publications aimed at creating awareness in the developing world to the needs for a quality assessment infrastructure. An ISO-produced document entitled

“Metrology, standardization and conformity assessment: building an infrastructure for sustainable development” has been made available on the JCDCMAS website ([www.jcdcmas.org](http://www.jcdcmas.org)). Another document produced by the BIPM, “The invisible line: quality assurance and well-being of the world”, was published in the ISO *Focus* magazine in October 2006 (pp. 8-10). A JCDCMAS workshop will be held in Lima (Peru) in October 2006, entitled “Effects of the bilateral and regional free-trade agreements on the metrology, accreditation and standardization systems”.

**OIML:** Prof. Wallard drew attention to meetings of the Presidium of the OIML and bureau of the CIPM in February and March 2006, at which it was agreed that bilateral cooperation between the two organizations should be reinforced in order to present a consistent image of international metrology to our stakeholders and the wider public. A number of joint actions were considered, and Prof. Wallard commented that it was a healthy and growing relation into which considerable effort was being devoted.

Dr Tanaka suggested that the RMOs should be invited to participate at meetings of the JCDCMAS. Prof. Wallard agreed that the BIPM tried to interact with RMOs wherever relevant, and that one or the other can deliver what is needed. However, if the RMOs were invited to attend the JCDCMAS then ILAC and ISO could also request that their regional organizations be represented, and this would lead to too many people.

Dr Semerjian enquired after the status of a possible “rapprochement” between the BIPM and the OIML. Prof. Wallard commented that a number of issues were being considered.

Prof. Göbel commented that in general he supported the closer working relationship with the OIML.

Dr Semerjian commented that this work of strengthening relations with the other international bodies was a very important role of the BIPM, and one that the NMIs could not do individually.

### 13 JOINT COMMITTEE FOR GUIDES IN METROLOGY

Prof. Wallard presented a brief report on the Joint Committee for Guides in Metrology (JCGM), of which he is Chairman.

The JCGM met in November 2005, for the first time since 1998, and agreed the following:

- to set deadlines for completion of the work on the two guidance documents currently in hand, the *International Vocabulary of Metrology, Basic and General Concepts and Associated Terms* (VIM; summer 2006) and *Supplement 1 to the Guide to the Expression of Uncertainty in Measurement* (S1 to the GUM; end of 2006);
- to revise the JCGM charter though maintaining the spirit of the original;
- that all partner bodies could make whatever use they felt appropriate of the guidance documents produced by the JCGM working groups;
- the representation of partner bodies in meetings of the working groups should be limited to two delegates per body, and that the partner bodies should make every effort to monitor nominated delegates so as to avoid long-standing “self-nominations”;
- projects for new guidance documents need to be proposed by the working groups to the JCGM for approval;
- to meet again in November 2006.

A key outcome of the meeting was the agreement that electronic versions of the revised VIM and the GUM supplements currently in preparation will be made freely available on the BIPM website. This decision will enable the BIPM to promote the guides as widely as possible. In due course, if the JCGM decides also to revise the current GUM, the new GUM will similarly be made available online. ISO will, as before, sell printed copies.

Working Group 2 has delivered a final draft of the VIM, which is currently being voted on by the partner bodies. The BIPM has circulated copies to the NMIs with a request for final editorial comments and encouragement to accept the document.

Working Group 1 is expected to complete the GUM supplements on schedule.

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

Prof. Issaev reminded the Committee of the discussion on the definition of certified reference material, raised under item 7.2 of the agenda. He added that there was also a problem with the word “accuracy”, for which two definitions exist in the present draft of the revised VIM.

## 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.

The period 2005-2006 has seen the finalization of several major policy-related projects, as well as some significant shifts in the BIPM’s scientific work.

As usual, this report presents detailed accounts of the scientific work undertaken over this period at the BIPM. One notable event was the start of the process of closure of the Length section, as decided by the 22nd CGPM, and the integration of relevant parts of its work into the Time section, re-named the Time, Frequency, and Gravimetry section, on 1 January 2006. Whilst, inevitably, there is a loss of some of the past activity, the combination of the expertise in the two sections will help us address the important issue of how the next generation of optical frequency standards can contribute to TAI. For the last time, the activities reported here are given under the headings of Time and Length.

**Length:** The BIPM optical comb facilities have been used for absolute frequency calibrations in the key comparison BIPM.L-K11, in the campaigns of November 2005 and May 2006. This extends the series of absolute frequency measurements to include some 37 lasers. In addition, the

participating lasers have been compared to the BIPM reference laser BIW 167 for a determination of their coefficients of sensitivity for parameters such as power, pressure and modulation effects.

In preparation for the discontinuation of the activities of the Length section, a consultation was undertaken among laboratories with an interest in pursuing BIPM.L-K11, and on the engagement of NMIs in piloting or hosting this comparison. Based on the responses to this consultation, the staff of the Length section will re-organize this key comparison and provide initial support to the future pilot laboratories.

The Length section provided calibration and measurement services for some BIPM users and for some specific external needs. In particular, for the frequency-stabilized lasers used in the gravimeters participating in the ICAG comparisons made at the BIPM in 2005, which were calibrated on site.

The BIPM offers a commercial service of assembling and filling iodine cells for use in stabilized-lasers and spectroscopy. During the period of this report, 18 cells have been prepared. Efforts have been made to further improve the quality of this service and to respond to the customer needs of the NMIs.

In dimensional metrology, the compact diode-pumped laser systems show excellent performance characteristics as sources for use in interferometry. For this purpose, a new type of iodine cell has been designed, fabricated by an external company and tested. They are to be used in the calculable capacitor and watt balance projects, and in a redesigned and more reliable absolute gravimeter. The seventh International Comparison of Absolute Gravimeters ICAG-2005 took place at the BIPM in early 2005. Sixteen countries participated in measurements with nineteen absolute gravimeters. Relative measurements have also been carried out with fifteen relative gravimeters from ten countries. The BIPM absolute gravimeter has been upgraded, and is undergoing improvement.

Support was provided to the Joint CCL/CCTF Working Group on Secondary Representations of the Second, in which some members of the staff have responsibilities.

An external audit of the quality procedures of the Length section took place in April 2006. As a result, the auditor found that the work was well

organized, and suggested only some minor changes in the quality documents.

**Mass:** Calibration certificates have been issued for ten 1 kg national prototypes and eleven 1 kg standards made of stainless steel, belonging to NMIs. Our software analysis capabilities have been upgraded significantly. Internal calibrations of submultiples of the kilogram have been provided to the Chemistry and Ionizing Radiation sections. We have established a new internal calibration service for pressure gauges that operate near atmospheric pressure. We now carry out calibrations every trimester on a routine basis and have already calibrated pressure gauges used by every technical section of the BIPM. To validate this service, we have carried out a bilateral comparison piloted by the LNE. This was followed by a peer review of our calibration service by an expert from METAS.

Our contributions to the International Avogadro Coordination project continue to be significant and appreciated. The recent installation of a new balance (Sartorius CCL 1007), which incorporates BIPM technology under a licensing agreement, will enable us to keep pace with growing metrological needs for vacuum weighing. As foreseen in the present work plan, we have completely refurbished the laboratory housing the new balance and three existing balances.

**Time:** The cooperation with the INRIM and the USNO for the calculation of uncertainties of  $[UTC - UTC(k)]$  continues; the method was refined and the uncertainties have been published in the *Circular T* and in the monthly updates of key comparison CCTF-K2001.UTC. The 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. Eight primary frequency standards contributed during the period to improve the accuracy of TAI, including four caesium fountains (IT CSF1, LNE-SYRTE FO2, NIST-F1, and NMIJ F1). A total correction of  $-6 \times 10^{-15}$  has been applied throughout the year to  $[f(EAL) - f(TAI)]$ . Since July 2005, the scale unit of TAI has been estimated to match the SI second to within  $1-2 \times 10^{-15}$ . To improve the accuracy of TAI arising from the contributions of primary frequency standards, the Time section is working closely with the new CCTF Working Group on Primary Frequency Standards.

New methods of clock comparison based on GPS observations have been studied for a future application in the calculation of TAI. Extensive comparisons of the different techniques and methods for clock comparison

are computed regularly and published on the internet. Two *ad hoc* study groups have been established by the CCTF Working Group on TAI to investigate the optimization of time links for TAI. Calibration programmes of existing GPS receivers have been organized and run by the Time section, and calibration of new types of GPS receivers and of GLONASS receivers have been investigated.

Support was provided to the Joint CCL/CCTF Working Group on Secondary Representations of the Second, in which some members of the staff have responsibilities. The section has been involved in discussions with experts from NMIs concerning the need of improvement in the performance of remote comparison techniques in order to take advantage of the performance of optical clocks for the international time scale.

Research work is also dedicated to space-time reference systems, particularly to the relativistic framework for defining and realizing coordinate times. Within the cooperation with the USNO (United States) for the provision of the Conventions Product Centre of the International Earth Rotation and Reference Systems Service (IERS), a user discussion forum has been set-up. Updates of the *IERS Conventions* (2003) have been published on the Conventions website, which is maintained at the BIPM.

An external audit of the quality procedures of the Time section took place in April 2006. As a result, the auditor qualified the work as well organized, and suggested only some minor changes in procedures and technical instructions.

**Electricity:** The training of the new members of the section (two of the three transferred from the Photometry and Radiometry section and one new staff member with experience in resistance metrology) in the activities of voltage and impedance metrology is progressing. One of the new members is now qualified to carry out measurements using the BIPM Josephson voltage standard and has already gained considerable experience comparing Josephson standards. A second staff member is making steady progress learning to operate the BIPM quantum Hall effect standard and was joined in May 2006 by the new recruit.

Considerable effort has gone into successfully completing six new on-site comparisons of Josephson standards in comparisons with the BEV, the CEM, the INETI, the INMETRO, the NMIA and the NMIJ. A seventh comparison, with the KRISS, produced no usable results and will have to be repeated. Work is nearing completion on the first of two projects in voltage

metrology: the development of a completely automated facility for measuring 1.018 V standards. Validation tests against the old equipment that it is replacing will soon begin. Work on the second project, the compact, more easily transported Josephson standard, is progressing. At the present time, the new cryoprobe is being constructed along with critical filters that are key components of the BIPM Josephson standards.

In the impedance area, the new cryogenic current comparator probe was successfully tested in a 100/1 ratio CCC bridge. All of our resistance measurements depend on the measurement of a 100  $\Omega$  resistance with the QHR standard. We have now completed a new thermostatted enclosure containing two first-quality 100  $\Omega$  standards, thus strengthening redundancy. We have obtained some exciting and promising results in our research cooperation with the LNE on the study of the metrological qualities of arrays of QHR devices that seem to be able to provide a way of checking resistance ratio measurements to within a few parts in  $10^9$ . We are reducing the uncertainty in our link from the QHR to standard capacitors by replacing the resistors in the quadrature bridge by new resistors in a temperature regulated enclosure.

Work on the characterization of Zener voltage standards with regard to noise and environmental effects is being stopped. Our conclusions concerning the limitations placed on uncertainties by  $1/f$  noise is now generally accepted and a staff shortage obliges us to cease measurements of Zener pressure and temperature coefficients. Using the methods of time series analysis, we have developed an expression for the standard deviation of the mean of white noise processes measured with an instrument fitted with a low-pass filter. The result agrees well with the results of a more general approach to calculating the uncertainty of the mean of correlated nondeterministic stationary processes recently proposed by the NIST.

In **thermometry**, the key comparison of water triple point cells, carried out by the BIPM for the CCT, has been finished. This comparison has demonstrated the need for more precision in the definition of the water triple point, which defines the kelvin. This problem has been solved by adding a clarification, which specifies the isotopic composition of the water used as a reference, to the kelvin definition in the 8th edition of the SI Brochure.

*Calculable capacitor:* The BIPM workshop is continuing the fabrication of components for the two calculable capacitors developed in collaboration

with the NMIA. A new type of iodine cell for the wavelength stabilization of the frequency-doubled Nd:YVO<sub>4</sub> laser has been developed and been successfully integrated into the laser. A second laser will be completed soon. The work on the capacitance bridge for the calibration of 1 pF capacitance standards against the calculable capacitor is finished. A model of the interferometer has been set up at the BIPM to investigate the performance of this system and to quantify the related uncertainty contributions.

*Watt balance:* The main characteristics of the magnetic circuit have been determined and we are currently trying to find a company capable of machining the soft iron parts with the required, very high, mechanical tolerances. A simplified magnet has been constructed which can be used before the definitive system becomes available. The balance suspension, including an electrostatic motor for the coil displacement, has been assembled. The system is equipped with optical sensors to measure its position. Work has started on controlling the position and velocity of the coil by a digital control system, which reads the position sensors and applies high voltages to the electrodes of the motor. Positions can be controlled within the whole travel range, and the velocity can be controlled at 0.2 mm/s, however with high velocity noise. Recently, an interferometer was integrated into the system, which will significantly improve the performance. An optical system was developed to align the interferometer beam vertical with respect to local gravity. Different ways of winding and of gluing the wire for a 1200 turn coil have been tested.

**Ionizing Radiation:** We have devised a new method for the re-determination of the air volume of the BIPM primary standard ionization chambers. This method, which is differential and involves precision dimensional measurements and Monte Carlo calculations, is lending evidence to an overestimation of the present volume. Coupled with the now published correction factors for the standard in <sup>60</sup>Co beams, the new BIPM air kerma determination will be higher than was proposed to the CCRI in 2005, but with a smaller uncertainty. The Monte Carlo calculations for the present absorbed dose to water standard also indicate a significant change. The new standards will be presented to the next CCRI for approval. The design of the graphite calorimeter for absorbed dose to water is being computer modelled. The measurement of specific heat capacity has been realized with an uncertainty of  $9.6 \times 10^{-4}$ , and a new differential method implemented to improve on this value, upon which the calorimeter will

depend. Five new dosimetry comparisons and two pilot mammography comparisons have been made. The equipment for the new brachytherapy comparison has been assembled. Four comparison reports have been published and the others are at different draft stages. Eight national secondary standards have been calibrated. The Quality System for calibrations was re-audited successfully. Considerable effort was expended to conform to the latest French environmental regulations concerning high activity  $^{60}\text{Co}$  sources.

We have complied with the CCRI(II) recommendation to group radionuclides by category and, for example, the  $^{55}\text{Fe}$  comparison that was selected to be held this year has the potential to support the measurement of 23 other radionuclides. Nineteen laboratories participated in this comparison, the results of which are yet to be analyzed. Cross-border movement of the radioactive material caused significant delays for some NMIs and has reduced the final participation. Eight laboratories submitted ampoules to twelve of the BIPM ongoing activity comparisons, including the short half-life radionuclides  $^{18}\text{F}$  and  $^{99\text{m}}\text{Tc}$ , using the International Reference System (SIR). Three pilot studies were also conducted, including the initial work for the planned  $^{85}\text{Kr}$  gas comparison. The new SIR measurement system is producing promising results and work is progressing well for the extension of the SIR to distant NMIs for short-lived radionuclides. Over the last twelve months, sixteen SIR comparison reports have been published. Some 2005 and all pre-2005 results are now in the KCDB while those remaining from 2005 have been analyzed and are circulating in draft A or B reports. Impurity activity levels were measured using the BIPM Ge(Li) gamma spectrometer for eight radionuclides submitted for comparisons. The NPL collaboration on the SIR efficiency curves was presented at an international conference and will be published as a *BIPM Monographie*. The BIPM Quality System is being extended to include the SIR, which is scheduled to be peer reviewed before the end of 2006.

**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 has coordinated the ozone reference standard comparison (CCQM-P28), and the final version of the report has been approved and published. The protocol for the future on-going key comparison (BIPM.QM-K1) will be finalized at the CCQM-GAWG meeting in November 2006. Quality System documents for the ozone comparisons (and future calibrations) have been updated following the outcome of CCQM-P28 and in preparation for BIPM.QM-K1. Validation of the OzonE software for its use in future key comparisons has been undertaken. The results of the study of systematic biases and measurement uncertainties for ozone standard reference photometers (SRPs) have been formalized in an article written in collaboration with the NIST and published in *Metrologia* (2006, **43**, 441-450). A frequency-doubled argon laser has been installed, and preliminary tests have been performed to set up a detailed workplan to build a laser-based SRP. The gas phase titration (GPT) facility has been refined allowing measurements of ozone over the lower mole fraction range (150-800) nmol/mol, whilst maintaining a standard measurement uncertainty of 0.3 %.

Development and validation work on BIPM's NO<sub>2</sub> primary facility has continued with the aid of two scientists on secondment to the BIPM from NMIs. Validation of the BIPM system against diluted higher concentration NO<sub>2</sub> cylinder mixtures and other dynamic generation facilities is planned in the future programme. The BIPM coordinated comparison of nitrogen monoxide standards, CCQM-P73, started in April 2006 with requests for standards with target concentrations sent to the 13 participating NMIs. Each participant has prepared two primary gravimetric NO standards in the range (30-70) µmol/mol, which will be analyzed at the BIPM.

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, and developing robust approaches and methodologies for the determination of purity. A dedicated facility for the larger scale handling, processing and storage of materials has also been established. A laboratory refurbishment to provide an area for controlled gravimetric transfer of materials and the accurate preparation of calibration solutions has commenced. Method development and validation studies required for applications in the production and characterization of the samples needed for the CCQM-P20.e comparison have been undertaken, focusing on the characterization of theophylline and related structure compounds from the

xanthine group. Methods developed for this purpose include LC-MS/MS methods, LC-UV methods, DSC techniques, Karl Fischer titration, and protocols for the preparation, stability testing and homogeneity assessment of gravimetrically spiked theophylline materials. The two candidate materials for CCQM-P20.e, in the form of individual 1 g sub-samples stored in amber glass vials, have been produced. A candidate digoxin material for CCQM P20.f, in the form of 250 mg sub-samples stored in amber glass vials, has also been produced. The BIPM's current programme is supported by collaborations with LGC in the studies related to theophylline and digoxin, and with NMIJ in the area of steroid hormones.

The Chemistry section provides the secretariat for the JCTLM. The third and fourth meetings of the Executive Committee of the JCTLM were held in 2005. A second set of nominations of higher order reference materials and reference measurement procedures were published in the JCTLM database, and a third call for nominations made. The procedure manual of JCTLM WG 2, Reference Measurement Laboratory Networks, was approved and published, and the first call for nominations of reference measurement services of laboratories was launched. The construction of an internet-based JCTLM searchable database was started in May 2006. The application will comprise a BIPM restricted-access back-office with a database and administrative forms and a front-office publicly available on the BIPM and IFCC websites. It has been designed to provide the user with a search engine based on a keyword search and to display lists of higher-order reference materials and reference measurement methods/procedures.

In preparation for the 2007 CGPM, a number of documents have been developed to assist in formulating the workprogramme of the Chemistry section in future years. A paper on a ten year forward plan for chemical metrology and its implications on the BIPM programme was presented to the CIPM in October 2005, and subsequently developed into proposals for the 2009-2012 period, taking into account the responses of a questionnaire developed by the BIPM on future trends and programmes in chemical metrology and bio-metrology, which was distributed to NMIs in early 2006. The BIPM metrology in chemistry 2009-2012 programme proposals have been developed along three major themes as advised by the CCQM, notably: gas metrology falling within the area of air quality and climate change; an organic chemistry programme addressing primary references for organic analysis in support of food, healthcare and forensic applications; and international liaison and coordination programmes. The CCQM advised

the BIPM to develop liaison activities in the area of bio-analysis, but not a laboratory programme at this time.

There were no comments from the CIPM and the report was approved.

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

Dr Kaarls commented that the BIPM Quality System was fully functioning.

Dr Semerjian asked when the Quality System would be applied to the Chemistry Section. Prof. Wallard confirmed that this would be before the end of 2006, before the first key comparisons took place.

#### **14.3 Safety procedures**

Prof. Wallard presented safety procedures.

Dr Semerjian remarked that NIST policy was to start all meetings with safety as the first point on the agenda. He was keen to increase safety awareness at the BIPM and Prof. Wallard accepted his suggestion that the CIPM should receive an annual report.

Dr Semerjian commented that there remained much room for improvement in safety at the BIPM, and noted that hazards and safety precautions should be clearly signed for each individual laboratory. As example he pointed out that appropriate eye protection should be worn in laboratories dealing with high-pressure gases. Mrs Perent agreed that the identified risks would be clearly signalled, adding that as a first step the safety guidelines had been collated for the site as a whole, and they would next be applied to each individual laboratory.

Prof. Issaev asked about Bureau Veritas, who had been asked to conduct an in-depth study of safety at the BIPM. Prof. Wallard explained that they had been engaged in a consultative role, to advise the BIPM on safety issues. The BIPM was not seeking accreditation or certification in this area.

#### **14.4 Residual activities of the former Length section**

Prof. Wallard presented residual activities after the closure of the BIPM Length section. In particular, piloting of the key comparison BIPM.L-K11

will be transferred to BEV (Austria) as CCL-K11, with regional nodes hosted by NRC (Canada), NMIJ (Japan), NPL (UK) and MIKES (Finland).

Dr Chung commented that the CCL was in favour of this transfer of pilot laboratory and encouraged the BEV to apply for membership of the CCL.

The CIPM approved Prof. Wallard's recommendation that the BIPM's iodine cell-filling service should continue with regular reviews to assess the level of internal and external demand, and that the BIPM's comb capability will be retained and maintained to meet internal needs within the BIPM's mission. The CIPM also agreed that the BIPM should continue to be involved in the planning of, and support for, an optical frequency transfer standard project, and should report to the CIPM on any long-term implications for a technical role that might emerge for the BIPM. Prof. Göbel commented that a job description for coordinator of this optical transfer standard project would be considered by the bureau, possibly as part of a new physicist's post for the Time, Frequency and Gravimetry section. Prof. Wallard added that the role was currently accomplished by Dr Lennart Robertsson, who would be replacing Dr Vitushkin on the gravimetry project after Dr Vitushkin's retirement in 2009.

#### **14.5 Presentation of the work of the BIPM by the Section Heads; laboratory visits**

As introduced in 2005, 30 minute oral presentations were made by each of the seven Heads of section during the morning of Wednesday 11 October, and two guided tours of the laboratories were held in the afternoon, each member visiting the laboratories he had not visited the previous year. The CIPM agreed that the new way of presenting an overview of the work and achievements of each section to the full Committee, followed by visits by half of the CIPM to half of the laboratories, with a reversal of the visiting groups in subsequent years, was a great improvement on the previous ad hoc system of visits.

On behalf of the CIPM Prof. Göbel thanked all the BIPM staff for their efforts.

#### 14.6 Depository of the metric prototypes

The visit to the depository of the metric prototypes in the Pavillon de Breteuil took place at 16:45 on 11 October 2006, in the presence of the President of the CIPM, the Director of the BIPM, and the representative 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 Madame Béchu, 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:	20.8 °C
maximum temperature:	21°C
minimum temperature:	20°C
relative humidity:	50 %

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

The Director of the BIPM,  A.J. Wallard	For the Curator of the Archives Nationales,  C. Béchu	The President of the CIPM,  E.O. Göbel
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### 15 PREPARATION FOR THE 23rd GENERAL CONFERENCE

#### 15.1 “Kaarls Report II”

Dr Kaarls reminded the Committee that the version presented was still a draft, and that comments and suggestions were welcomed. He had made a complete report to the Meeting of Directors the previous day, Monday 9

October, and would be incorporating their comments along with more economic details, as well as the ancillary sections such as bibliography, list of acronyms, and the BIPM elements once they are finalized.

He briefly outlined the structure of the report, saying that it was intended as a stand-alone document, which could be read and understood without reference to others. He expressed his thanks to all who had contributed to the present draft, citing in particular the work on materials metrology and IT, on chemistry, and the input of the bureau of the CIPM.

Prof. Göbel thanked Dr Kaarls for the work he had done, which had included a lot of research and travel to collect information from NMIs around the world. He noted that various points had already been raised at the Director's Meeting, such as which areas of work could be dealt with on a national level, and which others much be dealt with at the international level. There were no comments from the Committee on other points.

Prof. Göbel invited the CIPM to submit any comments to Dr Kaarls by 15 December, after which date the draft would be finalized, translated, edited and printed, ready for distribution in April 2007. He then turned to the proposed work programme of the BIPM, noting that this had consequences for the dotation proposed in the Convocation. He suggested that the work programme be discussed first, and invited Prof. Wallard to introduce the proposed work programme and accompanying resource document.

## **15.2 BIPM work programme**

Prof. Wallard presented the draft BIPM work programme for 2009 to 2012, which has been drawn up over the last two years based on the CIPM-approved criteria for the selection of work programmes, and how metrology is developing world-wide. He pointed out that the list of requests made by the Consultative Committees projects had been reduced considerably and that the work programme was the result of an intense process of prioritization between the Consultative Committees and the BIPM staff.

Taking section by section, he noted that the programme in time metrology was a continuation of the current programme, with a request for a software specialist to be recruited immediately into the vacancy left by the retirement of Mr Jacques Azoubib in September 2003. He added that a second vacancy

would be left by the departure of Dr Peter Wolf at the end of December 2006.

For the Mass section he requested the immediate appointment of a technician, and explained that the dual roles of the programme were to catch up with work that has not been done due to lack of staff as a result of the financial constraints, and to anticipate the future redefinition of the kilogram. Since the Head of section, Dr Richard Davis, will retire in 2010, a replacement will need to be recruited during the 2009-2012 programme.

In ionizing radiation the external priorities are changing. The proposed core programme is within the BIPM's existing resources, but a new project to have a linear accelerator for the dosimetry work is also proposed. As well as the capital costs, the latter would require the recruitment of one physicist and one technician.

The proposed programme in chemistry is based on major high-level drivers such as climate change and air quality and primary references for organic analysis in support of food, healthcare and forensic applications, including purity determination of organic materials. The CCQM wishes the BIPM to pilot more comparisons, and the recruitment of two more technicians would take this routine work away from the scientific staff. The Chemistry section will continue to attract secondments to undertake short-term scientific projects. This is considered particularly important in chemistry, where the priorities are changing rapidly.

On the support staff, Prof. Wallard noted that the administration and secretariat sections were very lean, and that the increase in the number of secondments to the BIPM was placing a huge demand on the Administration section in particular. He would like to strengthen the Administration section to free Mrs Perent and her assistant, Mr Rémi Cèbe, from routine work.

As agreed by the last CGPM, the Length section has closed and the staff members have been transferred to the new Time, Frequency and Gravimetry section. Two of these staff members will retire during the course of the next work programme.

Prof. Göbel thanked Prof. Wallard for his introduction, and invited discussion.

Dr Valdés highlighted the paucity of CMCs declared in the domain of frequency, and pointed out that frequency measurements were needed in a number of other domains, including electricity and magnetism, and acoustics, ultrasound and vibration.

Prof. Göbel thanked Dr Valdés but noted that it was a proposal to extend rather than restrict the proposed programme! After a brief discussion, the CIPM agreed that there was not much demand for special frequency calibrations or comparisons; GPS has been widely adopted, and if one absolute frequency is known then it can be transferred to other frequencies.

Dr Quinn commented that the area of time and frequency had not been brought into the CIPM MRA at the origin of the project, because the TAI system already existed and worked well. He expressed regret that it was now being incorporated into the system, but Prof. Göbel pointed out that this was being done at the request of the time and frequency community.

Dr Semerjian called for the resources required for the success of the BIPM watt balance to be made clear. There was some confusion amongst members about the number of posts indicated, and it was agreed that the table would be redrafted, to show the cross-section projects and to indicate research fellowships and other short-term posts in a separate column. It might be useful to separate the time frames, and include an overview of the total number of staff with time.

Dr Inglis pointed out that for successful succession planning it is preferable to advertise a long-term post and use the two-year probationary period to assess the person, rather than to advertise a short-term contract.

Dr Carneiro advocated presenting the work plan in terms of projects, detailing for each person the resources, capital investments, and running costs per year. In this way it is simpler to convert between the plan and the budget, and the whole system becomes more transparent. Prof. Göbel agreed that this was a good suggestion for a future work programme. Prof. Wallard pointed out that although the current work plan presents the person resources required at the programme level rather than project level, this total does not change; he added that the BIPM staff already multi-task in many cases.

Dr Semerjian turned the discussion to the linear accelerator facility, asking how Member States would be asked to fund it. He pointed out that the cost involved represents a considerable fraction of the budget. Prof. Wallard

replied that the request was for Member States to make an additional payment towards the capital budget in the first year. Dr Semerjian doubted that it was realistic to request an additional payment and to increase the dotation by nearly 20 %. Prof. Göbel called for the discussion to concentrate first on whether or not the project should be supported, and for discussion of the funding to follow afterwards.

Dr Tanaka expressed concern about the number of senior staff who would be leaving during the next work programme, and called for a long-term plan to be put in place. He also enquired about the possibility of recruiting retired staff, as can be done in Japan. Prof. Göbel replied that this was also a possibility in Germany, for a limited time period, but noted that it would not solve the problem at the BIPM. In particular, retired staff would not contribute to the pension fund. Prof. Wallard added that for senior posts a new person is usually in place one year before the staff member retires, to allow a sufficient period of overlap.

In response to another question from Dr Tanaka, Prof. Wallard said that the secondment programme had been very successful for short-term appointments, of between 1 week and 6 months. Since the last General Conference the BIPM has received about twenty short-term secondments. However, the only secondment of over 1 year had been for the post of Executive Secretary of the JCRB.

Prof. Issaev believed the programme was conditionally acceptable, but argued that a firmer basis was required for negotiations on the budget. He suggested that two or three versions of the work programme should be elaborated, to facilitate discussions at the CGPM. Prof. Göbel reminded the Committee that before the end of the present meeting they needed to approve both the work programme and the dotation to be inserted in the Convocation. He again called for the discussion to concentrate on the projects to include in the work programme.

Discussion then turned to the order of priorities the members of the CIPM accorded the various projects, labelled for the sake of brevity “watt balance” (with the recruitment of one staff member and including other work linked to the future redefinition of the kilogram), “chemistry” (meaning the recruitment of two technicians plus a number of short-term staff for the increased comparison programme), “linear accelerator” (meaning the recruitment of two staff and the installation of a new linear accelerator facility at the BIPM), and “international relations” (meaning the

recruitment of a new member of staff for that purpose). It was understood that the other projects in the work plan should continue as proposed.

There was general consensus that the “watt balance” project had the highest priority, and was an area in which the BIPM had a unique role. Dr Semerjian pointed out that the proposed recruitment for the Mass section related to the watt balance work, and suggested that this should be made clear in the work programme. Prof. Wallard noted that the project was supported as far as possible with existing cross-section staffing, to avoid locking the BIPM into the recruitment of dedicated specialists suitable for work that was only needed in the short-term.

On the linear accelerator project, Mr Énard raised the possibility of cooperating with the French metrology system, and their construction of a new linear accelerator in the Paris region. However, he warned that this was not a long-term solution as the LNE believed they would be using their facility at 100 % of its running time within a few years.

Dr Schwitz was unsure that the linear accelerator project would fulfil a unique role, and argued that such facilities at NMIs were not always used at 100 %. Prof. Göbel noted that it might also be possible to cooperate with the PTB in this area, as they were currently establishing new electron accelerator facilities covering the range from 0.5 MeV to 50 MeV. Dr Valdés noted that it would allow comparisons to be made between the relatively few NMIs currently equipped with their own linear accelerator, and provide an important reference facility for the many other (poorer) NMIs, who still need to provide a service to their hospitals. Dr Inglis advocated looking for alternative sources of funding for the accelerator, suggesting that the project could perhaps be co-funded.

Dr Carneiro believed that the proposed work programme and associated budget generally had the support of the CIPM, but that the projects should be prioritized irrespective of whether the funding could be found. He noted that the Danish Government preferred over-proposals, so that they could then make their own selection. He advised the BIPM to prepare a project-by-project budget and a list of priorities, in the knowledge that the work plan would have to be revised if the dotation agreed by the General Conference was insufficient to fund the work programme. He recalled that the demands of the Consultative Committees were not of themselves an adequate justification for a project, and that our principal clients, the Member States, could have other needs. It was the CIPM’s role to manage

the budget, and for this it was preferable not to deviate too far from the normal procedure, which was to establish a prioritized project-by-project basis.

Prof. Göbel again reminded the Committee that agreement had to be reached before the end of the meeting on the figures to be included in the Convocation to the Conference. The CIPM had to believe they were presenting a serious work plan, and to believe that the proposed increase in dotation was realistic. He asked whether members believed it realistic to ask for a 30 % increase in budget (which included a full implementation of the linear accelerator project), or to define what level of increase would be more plausible. The work programme would have to be revised in-line with this, and may have to be revised again following the CGPM.

Returning to the linear accelerator project, he noted that the BIPM Ionizing Radiation section provides the basis for traceability in dosimetry world wide, and that this is one of the cornerstones of the BIPM. He pointed out that the  $^{60}\text{Co}$  work will gradually decrease over the coming years, and it was clear that the linear accelerator project was a good one. The key question was whether we could afford to fund such a facility within the next work programme, or whether we should start planning the project ready to introduce it fully in the 2013-2016 work programme. Prof. Wallard added that although fairly few NMIs (currently eight) have their own linear accelerator, many more Member States have them in their national health systems. He understood that there are, for example, twelve linear accelerators in the hospitals of Bangkok (Thailand).

Dr Semerjian welcomed the suggestion of Mr Énard that the BIPM could use the LNE's linear accelerator in Paris, especially at the beginning when the LNE's facility was under-used. He suggested that this way the BIPM could build up its staffing more gradually, while the demand from NMIs continued to increase. By the time the following work programme was being discussed, in four years' time, the "shock effect" would have lessened.

Prof. Moscati pointed out that the idea of the BIPM having its own linear accelerator was not a new one; the CCRI has been discussing it for a number of years. The CCRI has also considered the possibility of the BIPM collaborating with other facilities, but believes it would be difficult to find sufficient time on external accelerators. He noted that although the initial investment was significant, the life span of an accelerator was quite long

(perhaps fifteen to twenty years), and on a per-year basis the sum required appeared more reasonable. He highlighted the importance of health-related measurements and the increasing use of radiation therapy in cancer treatment, and noted out that a 10 MeV accelerator would be sufficient to provide traceability for the coming years; the BIPM is presently limited to about 1 MeV. Prof. Göbel agreed the CCRI's recommendation was a good one, then turned the discussion to the proposed chemistry project.

Dr McLaren noted that the main rationale for recruiting two new technicians to the Chemistry section was so that the BIPM could pilot new key comparisons and pilot studies. So the main question for the NMIs to decide was whether they preferred to pilot the comparisons themselves, or to finance the BIPM to do it. The same applied to both pure substances and to gas mixtures. He then asked for more information on the role of the proposed postdoctoral fellows, pointing out that the CCQM *ad hoc* Working Group on Strategic Planning had made a strong recommendation to the BIPM not to start up a laboratory programme in bioanalytical laboratory work until priorities were clearer.

Dr Kaarls noted that although the larger NMIs could do nearly everything themselves, there was a clear demand in the CCQM, from nearly all NMIs, for the BIPM to organize more comparisons. The results of a survey undertaken at the time of the 22nd CGPM had demonstrated that the smaller NMIs have very different needs from the larger ones. The proposed recruitments would strengthen the BIPM's position in chemistry, bringing it more into balance with its traditional programme in physics.

Dr Carneiro asked if any of the existing projects at the BIPM could be phased out. He suggested that some comparisons could be piloted by NMIs, noting that it was important to strike the right balance.

In response to a question from Dr Schwitz, Prof. Wallard explained that any equipment for the new comparisons or laboratory work would be financed out of the normal laboratory budget. Dr Schwitz remarked that the use of BIPM staff to pilot comparisons on behalf of all NMIs provided good value for money.

Dr Semerjian believed that the ozone project had the highest priority project within the proposed chemistry programme. He noted that it was important for the discrepancy with the WMO measurements to be resolved, and he believed that the BIPM could make a valuable and unique contribution in this area, which would contribute to establishing the credibility of the BIPM

in chemistry. He was less convinced of the contribution the BIPM could make in the huge area of organic measurements, and the wide variety of associated measurement techniques. He asked if the presence of one or two extra people at the BIPM could really change the workload of the NMIs active in this area. Dr Kaarls noted that the advisory group of the CCQM, which included the Director of NIST's Chemical Science and Technology Laboratory, had unanimously agreed that they could. Dr McLaren added that the purity-assessment work being undertaken in the organic chemistry programme at the BIPM was complementary to the work in progress at the NIST. Prof. Göbel underlined that the BIPM had to address the worldwide needs of the metrology community in the important area of environmental, healthcare and food safety, adding that many of the smaller NMIs relied on the BIPM to do this.

Dr Hengstberger noted that the BIPM activity in chemistry had been initiated because the BIPM needed to be taken seriously by other organizations on the subject of traceability to the SI units in chemistry. It was clear that the BIPM could only have activity in selected areas, and what was important was achieving a "critical mass"; the new element now being added was that this critical mass could be achieved by undertaking more comparisons. Dr Hengstberger felt that any Consultative Committee would like the BIPM to undertake more comparisons and that this alone was not a convincing argument for adopting a programme.

Dr Kaarls agreed that the competence of the BIPM in chemistry relied on its scientists, not a demonstration that it could undertake comparisons. Nonetheless, the demand for more comparisons piloted by the BIPM was supported by the majority of Member States, including both small and large NMIs and by a number of IGOs.

Prof. Göbel then invited questions on the proposed "time and frequency" and "international" posts. Prof. Wallard noted that in time and frequency the proposal was to fill one vacancy immediately and to reorganize the section within the existing resources. Prof. Göbel commented that it seemed a reasonable project and had his support. He asked the members to comment on the need for a new "international" post.

In response to a question from Dr Semerjian, Prof. Wallard explained that the work was normally shared between the senior staff, in particular himself, the Executive Secretary of the JCRB, and the experts from the scientific sections (particularly Dr Wielgosz for relations with WMO, and

Dr Arias for relations with the IAU and IGS). These resources were now insufficient to cope with the increasing needs for liaisons and coordination, particularly bearing in mind the proposed project to encourage a new class of “Corresponding NMI of the BIPM”.

Dr Kaarls said the key issue was how much time could be spent on these relations considering the limited resources available. He did not give it the highest priority.

Dr Inglis suggested that the return on investment should be considered. He noted that the introduction of Associate States, adopted during the 21st CGPM in 1999, had been a great success, and was an additional source of funding, albeit at a certain level of expense.

Prof. Wallard pointed out that the plan was also to encourage some of these Associates to become Member States, and that it was necessary to invest in order to maximize the return. Dr Valdés asked if the CIPM MRA could be promoted in projects run by short-term staff. Prof. Wallard said that although the BIPM could promote the CIPM MRA at the highest level, it was important that this promotion be supported by interactions at the national level.

Dr Semerjian voiced his support for the proposed international post, commenting that this was one of the unique roles that only the BIPM could undertake; the NMIs must do their share of promotional work, but only the BIPM can speak to the international community. He asked what type of profile the BIPM would be looking for: a public relations person, or a scientist with good people skills? He noted that the BIPM could not continue to satisfy this growing area without appropriate resources.

In response to a query from Prof. Göbel, Prof. Wallard agreed that the international post could be a short-term contract, but repeated that it was more appropriate for this activity to be done by someone who was clearly a BIPM staff member. Prof. Göbel suggested that perhaps an incentive could be added, such as offering a long-term contract if the successful candidate was able to attract a certain number of new Member States or Associates.

Prof. Göbel expressed the general consensus that the work programme was basically accepted by the CIPM, but that funding for the capital costs of the linear accelerator project should not be included in the budget proposed for 2009 to 2012; instead, as a first step, investment should be made in appropriate staff with a view to funding the accelerator in the 2013-2016

work programme. Prof. Göbel commented that there was general agreement that the linear accelerator proposal was sound, but that a plan needed to be developed on how to put it in place.

Dr Semerjian agreed that it would be most appropriate to hire an additional member of staff to start up the linear accelerator programme in collaboration with other institutes, as a transition plan while demand for the project built up. This would be with a view to the capital investment being approved by the 24th CGPM in 2011, and he pointed out that the work programme should be modified to reflect this long-term plan.

Prof. Wallard suggested that there might be merit in leaving the proposal in the work programme for the time being, in the knowledge that it would spark debate. He noted that eight-to-ten-year plans should be indicated to the General Conference.

Prof. Moscati pointed out that more and more linear accelerators were being used around the world, even if only some eight NMIs were so equipped at present. He noted that the BIPM would be able to carry out calibrations for these as well as for the NMIs that do not have their own linear accelerator but are still responsible for the transfer to the user. He commented that although it was a big investment, the accelerator would last a long time, and that to rent one would represent nearly 1 % of the budget per year. He said he would prefer to let the CGPM take the decision.

Prof. Göbel thanked the CIPM for their comments, and turned the discussion to the associated budget.

### **15.3 BIPM dotation**

Mrs Perent distributed three outline budgets: the first (Scenario A) included all the projects presented in the draft work programme; the second (Scenario B) was without capital investment for the linear accelerator but included a physicist in preparation for launching the accelerator in the following programme; and the third “stand still” option (Scenario C) included just three new posts. The projected overall costs for 2009-2012 would have to be funded through the dotation, the contributions of Associates of the CGPM, and other sources of income. During the present programme these “other sources” have included the sale of BIPM photometry and radiometry equipment, the sale of iodine cells, and a

contribution from the IFCC towards the JCTLM secretariat, but these cannot be counted on for the 2009-2012 programme.

Mrs Perent noted that the starting point was the total dotation for 2008, voted by the previous CGPM. All three scenarios included an increase of 2 % per year to cover inflation. Scenario A would require an initial increase in dotation of 17.36 % plus an exceptional dotation in the first year, to finance the linear accelerator; Scenario B would represent an initial increase of 16.88 % in dotation; and Scenario C an initial increase of 9.8 %.

Prof. Göbel asked what, apart from the three extra staff, was included in Scenario C to explain the large increase. Mrs Perent explained that during the current period seven posts had been filled and that these had been financed both by additional income and by savings on projects. They would now need to be funded by the Member States. Prof. Wallard added that to balance the current budget, funds had had to be transferred from the BIPM reserves to finance, as agreed, the start-up costs of the Chemistry section.

In response to a question from Dr Semerjian, Mrs Perent confirmed that two extra members of staff (one scientist and one technician) were included in Scenario A for the linear accelerator project. At his request, she distributed a plot of the number of staff at the BIPM since 2000.

Prof. Kovalevsky asked how the level of 2 % for inflation had been decided, and suggested it might be appropriate to increase it slightly. Mrs Perent explained that no long-term forecast for inflation existed, but that estimates for the coming two years were between 1.8 % and 2 %. Dr Kaarls pointed out that the level of inflation could be adjusted by the Working Group on the Dotation during the General Conference, and Mrs Perent added that the French delegation at the General Conference often argued that the level of inflation should be reduced.

Mr Énard commented that the BIPM was unlikely to be awarded a 17 % increase in dotation. Prof. Kovalevsky agreed that it would be difficult to explain to the CGPM such an increase. He accepted that the arguments in the work programme were good, but commented that the problem was that the governments were reluctant to pay!

Dr Kaarls commented that if an increase of less than 10 % was accorded, the BIPM would be in trouble. Prof. Göbel confirmed that the BIPM would have to lose staff over the next period if less than the budget for Scenario C was adopted. Prof. Wallard added that redundancy costs were estimated at

200 000 € per member of staff and would represent a very significant additional cost to Member States if they did not accept Scenario C. He added that the percentage scientific productivity lost would far outweigh any percent in budget saved.

Prof. Kovalevsky returned to the size of the increase in dotation that might be accepted. If the 16.88 % of Scenario B was too much and 9.80 % of Scenario C probably too low, he suggested choosing a figure in between.

Dr Inglis commented that the BIPM was unlikely to get more than a 10 % increase, and counselled careful reflection before taking on three extra staff.

Dr Carneiro noted that the number of scientists was stable between 2004 and 2008. He commented that if the BIPM had a project-based research budget, then it might be able to find funding for staff and facilities from the Danish research budget. The Danish payment of the BIPM dotation, however, was covered by another government department. Mrs Perent commented that in most Member States the budget came from the government not the NMI, and that it could be from a different department for each Member State. Prof. Göbel added that the system relied on the delegates transmitting information to the relevant departments on the value and benefits the NMIs gained from the BIPM programme.

In response to a question from Dr Hengstberger, Prof. Wallard confirmed that the dotation at the previous Conference had been increased by 1.6 % in real terms, plus 1.4 % as a discretionary contribution.

Dr Quinn remarked that long-term secondments had not been very successful, but Dr Tanaka pointed out that short-term secondments had been a great success and recommended continuing the programme.

Dr Inglis suggested that a round-table survey of opinion would be worthwhile. If each member knows that the answer is no, there is no point wasting time discussing an increase of 17 %.

Dr Semerjian commented that, with the numbers of staff in many NMIs decreasing, the BIPM will need very convincing arguments for why its own staff numbers should increase. It is not appropriate to argue that more investment at the international level is needed to compensate decreasing investment at the national level, as it is clear that the BIPM should not undertake the work of the NMIs.

Prof. Issaev called for the proposals to be made clear to the decision makers, and suggested that the revolution in the SI could be used as a

convincing argument for the coming work programme; it is clear that changing definitions of the SI base units will generate extra work that can only be undertaken at the international level. He commented that it would be more difficult to justify the increase for environmental work etc., as national governments are aware of the tendencies at the national level.

Dr Quinn commented that there are fifty-one Member States, and each might be susceptible to a different argument.

Dr Tanaka agreed that the selling point for the 2007 dotation would be the redefinition of the SI units, adding that in 1999 it had been the CIPM MRA and in 2003 the watt balance project.

Prof. Wallard noted that at the last two CGPMs the BIPM had had to accept under-funding and has nevertheless delivered the majority of the work programme. He said that the BIPM could not take more money from the reserves, he could not identify any more internal savings, and he pointed out that no one had spoken against any part of the proposed work programme.

Prof. Göbel remarked that if agreement could not be found on the dotation, discussion would have to return to the work programme.

Dr Semerjian suggested that 2 % inflation should be shown separately for the changeover 2008 to 2009. For the level of inflation included, he recommended using the highest numbers quoted in the literature. Also, he recommended showing as a separate line the staff commitment (two or three people) made for the watt balance project (including the redefinition of the SI base units). This, he said, would at least secure 2 % + 6 % as a minimum increase. He thought it may be difficult to justify the increased programme in chemistry, but that a gradual increase should be included for the linear accelerator project, and perhaps a more reasonable increase for chemistry. He noted that the work programme would have to be revised if the funding was not forthcoming.

Dr McLaren noted that there were various sources of information on the level of inflation, and pointed out that the level of scientific inflation was much greater than that for the cost of living. Dr Quinn agreed that instead of discussing the headline inflation rate as usual, the scientific rate could be quoted. Dr Semerjian noted that at the 22nd CGPM the US delegation had been instructed to vote for a 0 % increase in real terms, but had not had any problem with the level of inflation proposed.

Dr Hengstberger suggested that another line could be included, indicating the amount needed in order to stop taking more funds from the reserves.

Dr Schwitz recommended that the CIPM concentrate on defining what programme of work was needed in order that the network of NMIs would continue to function and to highlight the unique functions that the BIPM alone could perform.

Prof. Göbel concluded that general consensus was that an increase of about 12 % might be a sensible starting point.

Dr Inglis supported this, but Prof. Wallard commented that such a low increase would make life at the BIPM very difficult. Dr Inglis reiterated that no one thought they could convince their government to support 17 %.

Prof. Wallard thought that a reasonable work programme could be proposed with an increase of about 15 %.

Dr Semerjian asked how the 15 % increase would be broken down. Prof. Wallard noted that it would be divided between staff costs, equipment costs, scientific inflation, maintenance, etc.

Dr Semerjian asked for clarification of which projects would be included, saying that his recommendation was for the linear accelerator to be given preference over the proposed new work in chemistry. Prof. Wallard commented that there were mixed feelings around the table, and that there was significant demand for increased BIPM support for comparisons in chemistry.

Dr Inglis commented that his top priority was for a new permanent position to look after the watt balance.

Dr Schwitz asked what fraction of the 15 % was to stop taking money from the BIPM reserves. Prof. Göbel commented that if 3 % was allowed for inflation and 4 % to stop taking from the reserves, this left an increase of just 8 % of the dotation.

Prof. Issaev commented that it was important to prioritize the projects, and to know which would be cut if the funding was not forthcoming. Dr Bennett believed that the identified priorities were the right ones, but the question remained of what increase would be acceptable to the governments. He asked for clarification on the level of the reserves, and Prof. Wallard explained that at the last CGPM the recommendation had been to reduce the reserves to about 40 % of the annual budget. He added

that the current belief was that they need to be kept at about 50 %, to cope with fluctuations in the payments received. He noted that, for example, the United States had not yet paid their contribution for 2006, which represented almost 10 % of the budget. Dr Bennett asked how firm the CIPM should be about the level of the reserves, and recommended that a clear statement be made. He noted that other selling points for the next work programme included the interest of other international bodies such as the WHO and WMO, and subjects such as health and the environment.

Dr Carneiro asked what reserves were needed for running the BIPM, and suggested carrying out a risk-assessment analysis. Prof. Wallard noted that the main variables were laboratory expenditure and maintenance. Dr Carneiro then asked what arguments could be used to justify an increase in budget of more than 0 % in real terms. He again recommended presenting the arguments for each project, explaining why it was needed and why the BIPM should do it. Prof. Wallard commented that this was indeed how the work programme had been constructed.

Dr Inglis reminded the Committee that agreement had to be reached on the level of increase to be printed in the Convocation. On a show of hands in favour of 15 %, Prof. Göbel concluded that an increase of 15 % should be presented in the Convocation, which includes a real increase of 11 % plus 4 % to cover inflation in a scientific organization. Dr Kaarls noted that the CGPM did not always agree what was requested, and that the CIPM may need to meet after the CGPM to decide the consequences for the work programme.

Dr Semerjian commented that a “recovery of the reserves” line could not be included as base funding; it was necessary to justify these 4 %. Prof. Wallard added that the level of the reserves had been reduced from 60 % to 50 %; the CGPM would not accept paying money back into the reserves.

Dr Inglis noted that a significant part of the BIPM’s income came from interest paid on the reserves; a reduction in reserves will result in a reduction of this income.

Prof. Wallard commented that the capital expenditure needed to launch the chemistry programme had been funded out of the reserves and that money for replacement equipment needed to be found from annual operating costs. The reserves were now increasingly being used to cover the financial shortfall caused by late payments from Member States. Dr Semerjian

argued that if the CGPM was not being asked to replenish the reserves, then it was not appropriate to include a reserves line in the budget, and asked if 3 % were allowed for inflation, how the remaining 12 % would be split.

Prof. Wallard remarked that the CIPM could only decide what to support when the final dotation was approved. However, the increase could be broken down to indicate the level of maintenance (about 5 %) and the scientific inflation for the laboratory expenditure. Dr Semerjian asked if perhaps the increases could be distributed differently, to reduce the initial big step, suggesting that perhaps the curve could follow the staff chart. Prof. Kovalevsky commented that in fact most Member States really wanted to know the total sum over four years.

Prof. Göbel concluded that a new draft budget and work programme would be produced based on a 15 % increase in dotation, including inflation.

Dr Semerjian again asked what about the order of priorities. If the 15 % were not funded, which projects would be maintained. Prof. Wallard replied that if a reduced level of dotation was funded by the CGPM, the CIPM would have to revise the work programme in terms of the real dotation. He did not believe it helpful to state the priorities at present.

Dr Semerjian reworded his question, asking what would be taken out of the work programme to propose an increase of 15 % to the CGPM. Dr Kaarls replied that this decision lay with the CIPM; the work programme would have to be rewritten in the light of the CIPM's recommendations.

There was general consensus that the "new SI" programme, including the watt balance project, was the highest project. Prof. Göbel asked if everyone agreed that the proposed extension of the chemistry programme was the lowest priority.

Dr Kaarls rated the chemistry programme as being of equal value to the ionizing radiation programme.

Dr Semerjian commented that the overlap between the proposed international post and the post of JCRB Executive Secretary was unclear. Prof. Wallard agreed that the international post could be recruited for a limited period with well-defined targets, and could perhaps subsequently be turned into a permanent post. The JCRB Executive Secretary post would continue to be supported by secondments from NMIs.

Dr Valdés commented that in Argentina when justifying the need for an improved definition of the kilogram, he often used the example of weighing

a truck: the uncertainty in weighing a truck of about 40 T (40 000 kg) is currently about 40 kg! He noted that it was easier to explain the need in chemistry than to explain the need for a linear accelerator, and gave his order of priorities as first mass, second chemistry, and third ionizing radiation.

Dr Schwitz gave his order as first the realization of units (including time and frequency), second increased international work, third chemistry and fourth ionizing radiation.

Prof. Leschiutta recommended that the BIPM preserved flexibility as far as possible, noting that priorities could change.

Prof. Issaev considered first time and frequency; second mass, third chemistry, and fourth ionizing radiation.

Dr Hengstberger commented that, although the CIPM is concerned with metrology at the highest level, too high a deviation from the demands of users can cause problems. He and Dr Bennett considered first mass; second time and frequency; third international work; fourth chemistry; and fifth ionizing radiation.

Dr Tanaka supported first mass; second chemistry; and third ionizing radiation. He commented that the BIPM should be the centre of gravity of worldwide facilities, and noted that the developing network in chemistry was encouraging. He was uneasy with the idea of having a linear accelerator at the BIPM when they were not available at the majority of NMIs.

Dr Chung generally agreed with Dr Tanaka, but he advised against making the priorities clear in the work programme presented.

Dr McLaren supported first mass, noting that this work was urgent, not all NMIs could do it, and the kilogram existed uniquely at the BIPM; second chemistry, including resources continuing to go into international liaisons; third the international post, although he would like to see a stronger business case in terms of leveraging funding, and would like to see a diversified funding portfolio. Lastly he placed ionizing radiation, noting that he was abstaining on time and frequency because he was not yet well enough informed on the project.

Prof. Gao Jie's priorities were based on the closeness of the relation to human life. So he rated chemistry most highly, and the mass projects lowest.

Prof. Göbel supported the mass project as the highest priority, noting that the time and frequency programme was equally important, but required a closer examination of the programme proposed. After that he rated the international work, then chemistry and ionizing radiation.

Prof. Göbel concluded the discussion, confirming that the bureau would work on the revised work programme on the basis of a 15 % increase in dotation and the comments received.

Prof. Gao Jie commented that 15 % was not a small number, but he was confident that he could persuade the Chinese government to support it. His principal arguments would be to support environmental protection, the food industry etc., and he would be using the Kaarls report as evidence. Prof. Göbel thanked Prof. Gao Jie for his support, although he was less optimistic about the response of the German government.

#### 15.4 Convocation

Prof. Wallard presented the draft Convocation of the 23rd CGPM, noting that minor changes had been proposed to the agenda to make it more logical. He outlined the formalities such as the various speeches at the start of the Conference, the presentation of the Draft Resolutions, and the formation of a Working Group on the Dotation to discuss the dotation.

##### List of Draft Resolutions

- A On the initiatives taken to strengthen the collaboration between National Metrology Institutes and recognized National Accreditation Bodies
- B On the report of the International Committee to the General Conference on Evolving Needs for Metrology in Trade, Industry and Society, and the Role of the International Bureau of Weights and Measures (BIPM)
- C Dotation of the International Bureau of Weights and Measures (BIPM) for the years 2009 to 2012
- D On the relevance to trade of the CIPM Mutual Recognition Arrangement, and other related Arrangements
- E On Associate States of the General Conference
- F On the acceptance of Economies as Associates of the General Conference

- G On the importance of promoting the work carried out under the Metre Convention and on the creation of the category of Corresponding National Metrology Institute of the International Bureau of Weights and Measures (BIPM), to encourage more States to accede to the Metre Convention or become Associates of the General Conference
- H On financial arrears of Member States
- I On the revision of the *mise en pratique* of the definition of the metre and the development of new optical frequency standards
- J Clarification of the definition of the kelvin, unit of thermodynamic temperature
- K On the importance of SI traceable measurements to monitor climate change
- L On the possible redefinition of certain base units of the International System of Units (SI)

Dr Semerjian noted that various editorial corrections were required. Prof. Göbel confirmed that this would be done, but turned attention first to the texts of the Draft Resolutions, inviting comments first on Draft Resolution B, on the Kaarls Report II.

**Draft Resolution A** was approved without comment.

**Draft Resolution B:**

Dr Quinn remarked that in this and several other Resolutions the General Conference should address the CIPM and the international community rather than the BIPM.

Dr Semerjian suggested that the word “innovation” should be worked into the title as it was increasingly used by many NMIs in their strategic plans.

Dr Bennett suggested broadening the range of the second dot point in the notes, perhaps adding another dot point, to mention trade and emerging technologies.

**Draft Resolution C:**

Prof. Göbel noted that the section on the work programme would be redrafted following the CIPM’s comments.

The CIPM approved Draft Resolution C with the removal of the bullet point on the exceptional dotation and with the dotation fixed with an increase of 15 % in the first year and with the following years adjusted to include inflation at an appropriate level. Prof. Göbel noted that an additional sentence might be added to prepare the way for the introduction of a linear accelerator in the following work programme.

**Draft Resolution D:**

Prof. Wallard commented that the absence of such a Resolution could be interpreted as the BIPM giving up on obtaining observer status of the WTO TBT. He commented that, on the contrary, this request was very much still on the table.

Dr Semerjian remarked that this was an action item, and suggested that a list of such action items be presented as a reminder at the end of the CGPM, perhaps as a PowerPoint slide, or even printed and distributed to delegates. Prof. Wallard agreed that perhaps this could best be done in the form of a follow-up letter to the delegates after the Conference.

**Draft Resolution E:**

Prof. Wallard remarked that a number of Associates of the CGPM were playing a significant role in some CCs, and had many CMCs declared in Appendix C of the CIPM MRA. It would be appropriate for these States to become full Members. Draft Resolution E was to encourage such States to make this step.

Prof. Gao Jie again raised the issue of political sensitivities, and Prof. Göbel re-assured him that the CIPM was well aware that only States with diplomatic relations with France may become Member States but agreed that the wording would be checked carefully. It was noted that there was, at the moment, no time limit for Associate status, and some Associates pay a considerable amount.

Dr Semerjian asked why Associates did not pay an entrance fee, and Prof. Wallard explained that this was an incentive to encourage States to apply for Associate Status. The CIPM agreed that the note to Article 11 in the Metre Convention, which specifies the entrance fee for Member States, could be modified with the addition “from which will be deducted payments paid as Associates”.

**Draft Resolution F** was approved without comment.

**Draft Resolution G:**

Dr Semerjian commented that the CIPM should first discuss the creation of a category of Corresponding NMI of the BIPM. He queried the choice of title, noting that NMIs did not belong to the BIPM, and asked what time duration was foreseen for such a category.

Prof. Wallard explained that the proposed category was a means of promoting the Metre Convention at minimal cost, as part of the BIPM's aim to be inclusive rather than exclusive. As with Draft Resolution E, the intention was to encourage membership of the Metre Convention.

Prof. Issaev remarked that such a category "free of charge" could be very fruitful. Prof. Wallard remarked that the bureau had considered it not worthwhile to ask for a symbolic subscription to cover postage costs.

Dr McLaren asked what incremental costs were implied, noting that probably they were already covered within the current budget. Prof. Wallard estimated the workload as 15 % to 20 % of a man year, commenting that this was one of the justifications for the proposed "international" post, discussed under 17.6 below. He noted that attendance at some events might be appropriate, such as workshops held for developing countries, saying that at present the BIPM attends some of these on a case-by-case basis.

Prof. Ugur expressed concern that creation of a category could in fact dissuade States from becoming paying Associates or Members. The CIPM agreed that it was important to fix a time limit for the proposed category of Corresponding NMI of the BIPM, and after discussion it was agreed that this should be three years, renewable once.

Mr Érard pointed out that it was important to make clear what Corresponding NMIs were *not* entitled to. Dr Quinn recommended that the words "Corresponding NMI of the BIPM" be included in the title of the Draft Resolution.

Dr Tanaka asked about the status of Corresponding Members of the RMOs. Prof. Wallard replied that the BIPM met them informally at RMO General Assemblies, but there was no formal link between them and the BIPM. Prof. Göbel agreed that it was of interest that States be attached to RMOs, but noted that this was a regional issue rather than one for the CIPM.

Prof. Moscati clarified that there could be more than one Corresponding NMI per State, but that this status would be dropped when the State became an Associate or Member.

Dr Schwitz remarked that the title of Corresponding NMI provided an official category for institutes with which the BIPM would correspond anyway, with the advantage of imposing a time limit.

Draft Resolution G was approved with the minor modifications discussed.

**Draft Resolution H:**

Prof. Wallard noted that Draft Resolution H was sensitive, and that until now no Member State has been excluded from the Metre Convention, due to the reluctance of the French Government to act to exclude a State. Dr Kaarls commented that no intergovernmental organizations really exclude a Member State, but it was important to bring the issue to the forefront. The rules were set in the Metre Convention, even though they may not be followed. Mrs Perent added that the idea was to apply pressure on the debtor States by openly discussing their situation at the CGPM.

Dr Semerjian asked why a “unanimous vote” was specified in the fifth point under “decides”. Dr Kaarls explained that this had been recommended by the French Government. The CIPM agreed that it would be more appropriate to use the same wording as for the vote on the dotation, which stipulate no votes against.

Draft Resolution H was approved with this minor rewording.

**Draft Resolution I** was approved without comment.

**Draft Resolution J:**

Draft Resolution J was approved after checking of the numbers specifying the composition of Vienna Standard Mean Ocean Water.

**Draft Resolution K:**

Draft Resolution K was approved with minor rewording to include the conference on meteorology and metrology in the “welcomes” point.

**Draft Resolution L:**

Draft Resolution L was approved with minor rewording to make clear the aim was to improve knowledge of the fundamental constants and the recommendation was to pursue the relevant experiments “with vigour”.

**16 METROLOGIA**

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

He reminded the Committee that since the beginning of 2003, *Metrologia* has been produced in partnership with Institute of Physics Publishing (IOPP) Ltd. The technical details of the production of *Metrologia* between the BIPM and IOPP are continuing to work well.

The accept-to-web publication times have fallen by 37 % since 2004, and authors can now expect their paper to be published online in just over a month after acceptance. All papers are available for downloading free of charge for one month after publication online, and some can be made permanently free (<http://www.iop.org/EJ/metrologia/>).

*Metrologia*'s impact factor has risen to 1.479 in 2005, which is the highest impact factor of related journals. The printed journal appears on time and we benefit from IOPP's extensive marketing network to assist in maintaining the subscription levels of the journal at a time when subscription levels are falling for the majority of scientific journals. The total number of subscriptions has increased, which is mainly due to IOPP selling *Metrologia* as part of its journal "packs".

There have been three special issues of *Metrologia* over the last year: issue **42(6)** containing significant papers from the "4th CCM International Conference on Pressure Metrology from Ultra-High Vacuum to Very High Pressure"; issue **43(2)** containing significant papers from the "9th International Conference on new Developments and Applications in Optical Radiometry (NEWRAD 2005)"; and issue **43(4)** on "Statistical and Probabilistic Methods for Metrology".

The *Technical Supplement* to *Metrologia* continues to grow, with 43 abstracts published in 2005, and 41 already online in 2006.

Prof. Göbel thanked Dr Williams for his report and asked about the future of the IOPP contract, which was due to terminate in November 2007. Dr Williams replied that he was keen to continue the partnership with IOPP, and commented that, because the journal's impact factor was steadily increasing, the BIPM was in a strong position to negotiate.

Prof. Wallard asked if the Editorial Board was functioning as it should. Dr Williams said he was careful not to overload its members, and consulted them only as a last resort in an effort to find potential referees.

Prof. Issaev said he had been delighted to see the special issue on statistics, which would be useful for everyone involved in metrology, and Dr McLaren and Dr Semerjian congratulated Dr Williams on the excellent performance of the journal.

## **17 ADMINISTRATIVE AND FINANCIAL AFFAIRS**

### **17.1 *Rapport aux Gouvernements for 2005***

Mrs Perent presented the *Rapport annuel aux Gouvernements des Hautes parties contractantes sur la situation administrative et financière du Bureau international des poids et mesures en 2005*, which had already been circulated.

At the request of Dr Semerjian, Mrs Perent noted that the *Rapport* and the other financial and administrative documents would be circulated to the Committee in advance of future CIPM meetings.

### **17.2 *Quietus for 2005***

Prof. Göbel drew the attention of Members to the first page of the report of the auditors' report 2005, confirming the accounts presented in the *Rapport annuel*. The CIPM gave quietus for the 2005 accounts.

Dr Semerjian asked how often the United Nations coefficients change. Mrs Perent explained that the coefficients are fixed by the United Nations every three years.

### **17.3 *Progress report on 2006***

Prof. Wallard presented the progress report on 2006 and commented that to balance the budget it was necessary to transfer 66 400 € from the reserves.

The CIPM approved the report and the transfer without discussion.

#### 17.4 Budget for 2007

Prof. Wallard presented the budget for 2007 and noted that this proposed a transfer of 159 000 € from the reserves.

#### Budget for 2007

<b>Income</b>		euros
<i>Budgetary income:</i>		
1. Contributions from the States		10 105 118
2. Interest on capital		291 000
3. Miscellaneous income		125 400
4. Subscriptions from the Associates		197 485
5. <i>Metrologia</i>		95 000
6. Transfer from Account I.– Ordinary funds		158 697
<b>Total</b>		<b>10 972 700</b>
<b>Expenditure</b>		
<i>A. Staff expenses:</i>		
1. Salaries	4 342 000	} 5 787 000
2. Family and social allowances	986 700	
3. Social expenses	458 300	
<i>B. Contribution to the pension fund:</i>		1 800 000
<i>C. Operating expenses:</i>		
1. Heating, water, electrical energy	219 700	} 1 209 700
2. Insurance	39 600	
3. Publications	100 800	
4. Office expenses	150 600	
5. Meeting expenses	180 000	
6. Travel expenses and freight charges	316 700	
7. Library	176 000	
8. Bureau of the CIPM	26 300	
<i>D. Laboratories:</i>		1 600 000
<i>E. Buildings (major maintenance and renovation):</i>		494 000
<i>F. Miscellaneous and unforeseen expenses:</i>		82 000
<b>Total</b>		<b>10 972 700</b>

In response to a question from Prof. Göbel, he confirmed that the proposed budget included the cost of the three extra staff.

Dr Semerjian asked what the traditional level of building maintenance was. Prof. Wallard explained that traditionally building maintenance represented about 5 % of expenditure. This level had been reduced in recent years to save costs, but significant work was now urgently needed. Even the roof above the Grande Salle was leaking.

Dr Quinn added that a study undertaken on expenditure since 1875 showed that the level of building maintenance has always been between 5 % and 8 %. He very much supported a return in the level of maintenance to this sort of level.

### **17.5 Member States in arrears**

Mrs Perent noted that four Member States were currently in arrears: the Republic of Cameroon, the Dominican Republic, the Islamic Republic of Iran, and the Democratic People's Republic of Korea.

She reminded the Committee that after three years of non-payment, a Member State in arrears can no longer participate in the activities and benefits of the Metre Convention. The Metre Convention provides for the exclusion of a debtor State after six years of non-payment, but she noted that this had never been applied.

Mrs Perent outlined the state of negotiations with the four Member States in question.

A plan for repayment had been agreed with Cameroon in 1998, and repayments started. These have since stopped, and new communications remain unanswered. The Republic of Cameroon currently owes 400 000 €

The Dominican Republic owes 891 558 €

Discussions with the Government of Iran are active. Iran has expressed interest in benefiting from calibration services, but discussions continue on how to settle the debt of 1 200 000 €. One of their latest communications argues that they requested "suspension" of their membership in 1979, and therefore the calculations of the debt are not correct. As indicated in the Secretary's Report (section 2.5) this "suspension" was not interpreted by the BIPM as "resignation".

The Democratic People's Republic of Korea owes over 600 000 € after nearly 18 years of non-payment. Attempts to establish contact have been unsuccessful.

Finally, Mrs Perent noted that the plan to reschedule Uruguay's debts, reported in 2005, had been successful and Uruguay was no longer in arrears.

#### 17.6 BIPM staff: promotions, departures, recruitment, and Statute

Prof. Wallard presented three proposed staff promotions.\*

A brief discussion ensued on the grades available to scientists at the BIPM. Dr Semerjian requested that the general term "scientist" be used rather than specifying "physicist" or "chemist". Mrs Perent commented that discussions were in hand to revise the various categories, and an effort would be made to make the grades more understandable in a new version of the statutes currently in preparation.

Various members of the Committee, including Prof. Göbel and Dr Semerjian, expressed reluctance to automatically link a grade to a function.

After discussion, the Committee approved the promotions of Dr Michael Stock, Dr Claudine Thomas, and Dr Robert Wielgosz to the highest grade (*physicien chercheur principal*, or *chimiste chercheur principal*).

Prof. Wallard then presented the proposed creation of three new positions at the BIPM: (1) an assistant for the Time, Frequency and Gravimetry section, to be fully conversant with the software and to work with the physicists to calculate TAI; (2) a technician for the Mass section, again with software experience; (3) a fixed-term post to look after International Affairs, to be recruited after the CGPM. Prof. Wallard added that, as discussed, the latter post would be associated with clear targets and incentives. He added that although some parts of the role could be carried out by a secondee to the post of JCRB Executive Secretary, other parts were only appropriate for a member of the BIPM staff.

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\* Erratum: Last year we mentioned the promotion of Dr Susanne Picard to *physicien principal* from 1 January 2005 instead of 2006.

Prof. Göbel invited comments. Dr Kaarls and Mr Énard were in favour of recruitment of a technician for the Mass section, but wanted to reconsider the other two posts. Dr Tanaka also expressed his support for the recruitment of a technician for the Mass section, and the Committee approved this post by consensus.

Dr Semerjian asked if there was no one available internally that could fulfil post (1). Dr Kaarls added that it was clear that the Time, Frequency and Gravimetry section needed a software expert; but the question remained of who this should be.

In response to a question from Prof. Göbel, Prof. Wallard confirmed that the BIPM would also be seeking to replace Dr Peter Wolf, physicist in the Time, Frequency and Gravimetry Section, leaving the BIPM at the end of 2006. Dr Kaarls asked if the replacement for Dr Wolf could not also fulfil the software needs. Prof. Göbel suggested hiring the software expert now, and replacing Dr Wolf later.

Dr Semerjian asked if Dr Lennart Robertsson could not replace Dr Wolf. Prof. Wallard explained that although Dr Robertsson could do this for the time being, the plan was for Dr Robertsson to replace Dr Vitushkin in the gravimetry work after Dr Vitushkin's retirement in 2009. Dr Semerjian commented that he would also like to discuss the gravimetry programme in due course, pointing out that very few NMIs are concerned with gravimetry. Prof. Wallard replied that three-yearly gravimetry comparisons (known as ICAGs) were piloted at the BIPM as part of the CCM activities. Prof. Göbel added that the gravimetry activities at the BIPM had been discussed when the Time, Frequency and Gravimetry section had been renamed.

Prof. Wallard repeated that the request was for approval to fill an unfilled vacancy (left by the retirement of Dr Azoubib in 2003) with a software specialist, and to fill the vacancy that would be left by the departure of Peter Wolf at the end of 2006. He pointed out that it was part of the Director's role to recruit appropriate staff to fulfil the work programme, and noted that these posts were covered by the budget that the Committee had approved for 2007.

After further discussion it was agreed that a software specialist for the Time, Frequency and Gravimetry section should be recruited now, and a job description for the physicist's post would be drawn up and discussed with the bureau.

Discussion on the international post was postponed until the next CIPM meeting; after the CGPM the interests of the Member States in various international activities should be clearer and the dotation will have been decided.

## **18 OTHER BUSINESS**

### **18.1 Varenna Summer School**

Prof. Leschiutta reported that the Varenna Summer School had been successfully held in July 2006 and had involved sixty students and twenty teachers. Forty-five students had been from institutes outside Italy, and fourteen students had had their travel and accommodation expenses paid. The Italian Physical Society were planning to adopt a fixed six-year schedule for their metrology summer schools, and would be careful to avoid clashes in dates and overlaps in subject with the BIPM.

Prof. Göbel thanked Prof. Leschiutta for the information, and again expressed his thanks for his contributions to the CIPM.

### **18.2 The Former Yugoslav Republic of Macedonia**

Mrs Perent announced that the Former Yugoslav Republic of Macedonia has the status of Associate of the CGPM with effect from 10 October 2006.

## **19 DATE OF NEXT MEETING**

The 96th meeting of the CIPM will take place at the Pavillon de Breteuil from Wednesday 7 to Friday 9 November 2007 before the 23rd CGPM, and will reconvene briefly after the close of the General Conference on the afternoon of Friday 16 November 2007.

Prof. Göbel closed the 95th meeting by thanking all members for contributing to a successful meeting.

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

### RECOMMENDATION 1 (CI-2006):

#### Concerning secondary representations of the second

The International Committee for Weights and Measures (CIPM),

**considering** that

- a common list of “Recommended values of standard frequencies for applications including the practical realization of the metre and secondary representations of the second” shall be established,
- the CCL/CCTF Joint Working Group (JWG) on the *Mise en Pratique* of the Definition of the Metre and the Secondary Representations of the Second in its meeting at the International Bureau of Weights and Measures (BIPM) in September 2005 discussed possible candidates to be included in this list for secondary representations of the second,
- the CCL/CCTF JWG reviewed and updated the values for the Hg ion, Sr ion, Yb ion, and the Sr neutral atom transition frequencies in its session in September 2006,
- the CCTF in its Recommendation CCTF 1 (2004) already recommended the unperturbed ground-state hyperfine quantum transition frequency of  $^{87}\text{Rb}$  as a secondary representation of the second;

**recommends** that the following transition frequencies shall be used as secondary representations of the second and be included into the new list of “Recommended values of standard frequencies for applications including the practical realization of the metre and secondary representations of the second”

- the unperturbed ground-state hyperfine quantum transition of  $^{87}\text{Rb}$  with a frequency of  $f_{^{87}\text{Rb}} = 6\,834\,682\,610.904\,324$  Hz and an estimated relative standard uncertainty of  $3 \times 10^{-15}$ ,

- the unperturbed optical  $5s\ ^2S_{1/2} - 4d\ ^2D_{5/2}$  transition of the  $^{88}\text{Sr}^+$  ion with a frequency of  $f_{^{88}\text{Sr}^+} = 444\ 779\ 044\ 095\ 484$  Hz and a relative uncertainty of  $7 \times 10^{-15}$ ,
- the unperturbed optical  $5d^{10}\ 6s\ ^2S_{1/2} (F = 0) - 5d^9\ 6s^2\ ^2D_{5/2} (F = 2)$  transition of the  $^{199}\text{Hg}^+$  ion with a frequency of  $f_{^{199}\text{Hg}^+} = 1\ 064\ 721\ 609\ 899\ 145$  Hz and a relative standard uncertainty of  $3 \times 10^{-15}$ ,
- the unperturbed optical  $6s\ ^2S_{1/2} (F = 0) - 5d\ ^2D_{3/2} (F = 2)$  transition of the  $^{171}\text{Yb}^+$  ion with a frequency of  $f_{^{171}\text{Yb}^+} = 688\ 358\ 979\ 309\ 308$  Hz and a relative standard uncertainty of  $9 \times 10^{-15}$ ,
- the unperturbed optical transition  $5s^2\ ^1S_0 - 5s\ 5p\ ^3P_0$  of the  $^{87}\text{Sr}$  neutral atom with a frequency of  $f_{^{87}\text{Sr}} = 429\ 228\ 004\ 229\ 877$  Hz and a relative standard uncertainty of  $1.5 \times 10^{-14}$ .

**RECOMMENDATION 2 (CI-2006):  
Coordination of the development of advanced time and frequency transfer techniques**

The International Committee for Weights and Measures (CIPM),

**recognizing**

- the availability of high performance cold atom microwave clocks,
- the rapid improvement of optical frequency standards in different institutes,
- the upcoming need to compare these remote standards at a level of estimated accuracy and stability which is not currently possible; and

**considering that**

- different technical possibilities for comparison that include optical fibre links, transportable optical frequency standards, optical satellite links and improved microwave links have been identified as possibly useful for the purpose,
- improvements in time and frequency transfer would have major applications to the performance assessment of current frequency standards and would support the progress of future primary frequency standards and clocks,
- the associated improvement of the realization of Coordinated Universal Time (UTC) would be beneficial for foreseeable applications in many fields of science and technology,
- a new Working Group on Coordination of the Development of Advanced Time and Frequency Transfer Techniques composed of experts from various fields, such as optical frequency metrology, time scale generation, and time and frequency transfer, to address and coordinate these issues is established;

**recommends that**

- the time and frequency community actively pursue this research in a coordinated manner,

- the International Bureau of Weights and Measures (BIPM) continue to facilitate the activities of the different working groups of the CCTF and establish the necessary interactions with other relevant bodies such as the International GNSS Service (IGS), International Union of Geodesy and Geophysics (IUGG), International Telecommunication Union (ITU), International Union of Radio Science (URSI) and other competent organizations,
- national and international science organizations and space agencies give this development due consideration and weight, and
- national governments and international bodies provide funding to support the development of these activities.

## LIST OF ACRONYMS USED IN THE PRESENT VOLUME

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

AFRIMETS	Inter-Africa Metrology System
BAM	Bundesanstalt für Materialforschung und -prüfung, Berlin (Germany)
BEV	Bundesamt für Eich- und Vermessungswesen, Vienna (Austria)
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
CCRI	Consultative Committee for Ionizing Radiation/ Comité Consultatif des Rayonnements Ionisants
CCT	Consultative Committee for Thermometry/ Comité Consultatif de Thermométrie

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

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
CIML	Comité International de Métrologie Légale
CIPM	International Committee for Weights and Measures/ Comité International des Poids et Mesures
CODATA	Committee on Data for Science and Technology
Codex Alimentarius	Commission created by the FAO and the WHO to develop food standards, guidelines and codes of practice
COOMET	Coopération métrologique entre les États d'Europe centrale/Cooperation in Metrology among the Central European Countries
CPEM	Conference on Precision Electromagnetic Measurements
CSIR-NML*	Council for Scientific and Industrial Research, National Metrology Laboratory, Pretoria (South Africa), see NMISA
DI	Designated Institute
EC	European Commission
EUROMET	European Collaboration in Measurement Standards
GAWG	CCQM Working Group on Gas Analysis
IAEA	International Atomic Energy Agency
IAU	International Astronomical Union
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
IGO	Intergovernmental Organization
IGS	International GNSS Service

ILAC	International Laboratory Accreditation Cooperation
ILO	International Labour Organization
IMGC*	Istituto di Metrologia G. Colonnetti, Turin (Italy), see INRIM
INETI	Instituto Nacional de Engenharia e Tecnologia Industrial, Lisbon (Portugal)
INMETRO	Instituto Nacional de Metrologia, Normalizaçao 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)
IRMM	Institute for Reference Materials and Measurements, European Commission
ISO	International Organization for Standardization
ISO REMCO	International Organization for Standardization, Committee
ITU	International Telecommunication Union
IUGG	International Union of Geodesy and Geophysics
IUPAC	International Union of Pure and Applied Chemistry
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
JWG	Joint 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)
LNEC	Laboratório Nacional de Engenharia Civil, Lisboa (Portugal)
LNE-SYRTE	Laboratoire National de Métrologie et d'Essais, Systèmes de Référence Temps Espace, Paris (France)
METAS	Swiss Federal Office of Metrology, Wabern (Switzerland)
MIKES	Mittatekniikan Keskus/Centre for Metrology and Accreditation, Helsinki (Finland)
MRA	Mutual Recognition Arrangement

NAB	National Accreditation Body
NCSLI	National Conference of Standards Laboratories, Boulder CO (United States)
NEWRAD	New Developments and Applications in Optical Radiometry Conference
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)
NMISA	(ex CSIR NML) National Metrology Institute of South Africa, Pretoria (South Africa)
NML*	See CSIR-NML
NPL	National Physical Laboratory, Teddington (United Kingdom)
NRC	National Research Council of Canada, Ottawa (Canada)
NRC INMS	National Research Council of Canada, Institute for National Measurement Standards, Ottawa (Canada)
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
SADC MET	Southern African Development Community Cooperation in Measurement Traceability
SIM	Sistema Interamericano de Metrología
SPRING	Standards, Productivity and Innovation Board, Singapore (Singapore)
SYRTE*	Systèmes de Référence Temps Espace, see LNE-SYRTE
TC	Technical Committee
TG	Task Group
UME	Ulusal Metroloji Enstitüsü/National Metrology Institute, Marmara Research Centre, Gebze-Kocaeli (Turkey)

UNIDO	United Nations Industrial Development Organization
USNO	U.S. Naval Observatory, Washington DC (United States)
URSI	International Union of Radio Science
VNIMS	Russian Research Institute for Metrological Service of Rostekhnregulirovaniye of Russia, Moscow (Russian Fed.)
VSL*	Van Swinden Laboratorium, see NMi VSL
WADA	World Anti Doping Agency
WCO	World Customs Organization
WG	Working Group
WG-CMC	Working Group on CMCs
WGDM	CCL Working Group on Dimensional Metrology
WGKC	Working Group on Key Comparisons
WG-SP	Working Group on Strategic Planning
WGUV	Working Group on Ultraviolet
WHO	World Health Organization
WMO	World Meteorological Organization
WTO	World Trade Organization
WTO-TBT	World Trade Organization, Technical Barriers to Trade Committee

## 2 Acronyms for scientific terms

BMC	Best Measurement Capability
CGS	Centimetre, gram, second system of unit
CMC	Calibration and Measurement Capability
DSC	Differential Scanning Calorimetry
EAL	Free Atomic Time Scale/Échelle Atomique Libre
EQAS	External Quality Control System
GLONASS	Global Navigation Satellite System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GPT	Gas-phase Titration
GUM	<i>Guide to the Expression of Uncertainty in Measurement</i>
IT	Information Technology
IVD	<i>In Vitro</i> Diagnostic
KCDB	BIPM Key Comparison Database
KCRV	Key Comparison Reference Value
LC	Liquid Chromatography
MAS	Metrology, Accreditation and Standardization

MS	Mass Spectrometry
QHR	Quantum Hall Resistance
SI	International System of Units/Système International d'Unités
SIR	International Reference System for gamma-ray emitting radionuclides
SRP	Standard Resistance Photometer
TAI	International Atomic Time
UTC	Coordinated Universal Time
UV	Ultraviolet
VIM	<i>International Vocabulary of Basic and General Terms in Metrology</i> renamed <i>International Vocabulary of Metrology, Basic and General Concepts and Associated Terms</i>

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