

**International Committee  
for Weights and Measures**  
Proceedings of Session II  
of the 104th meeting  
(15-16 October 2015)

## **Executive Summary**

### **Session II of the 104th meeting of the CIPM (15-16 October 2015)**

#### **Pension Fund Advisory Board**

The CIPM decided to establish a Pension Fund Advisory Board (PFAB) that will take over the responsibilities of the CIPM Sub-Committee on the BIPM Pension and Provident Fund and Health Insurance relating to pensions. The Sub-Committee was subsequently closed.

#### **BIPM Health Insurance scheme**

Responsibility for the BIPM Health Insurance scheme has been transferred to the CIPM *ad hoc* Working Group on Conditions of Employment.

#### **BIPM Pension Fund**

The CIPM reaffirmed its commitment to ensure that the BIPM Pension Fund be placed on a financially sustainable basis in order that it is sufficient to support pension benefits in the long term.

#### **GULFMET**

The CIPM granted provisional acceptance of GULFMET as a RMO.

#### **CIPM MRA review**

A progress report was given on the review of the CIPM MRA, including the proposal to establish a Working Group on the Implementation and Operation of the CIPM MRA.

#### **Updates to the list of standard frequencies**

The CIPM adopted the CCTF and CCL Recommendation 'Updates to the list of standard frequencies' as Recommendation 2 (CI-2015).

#### **Membership and observership of the CCs**

The policy for approving and reviewing membership and observership of the CCs will be reviewed at the meeting of CC Presidents in June 2016.

#### **BIPM terminology**

The current practice relating to the terminology used to describe the BIPM and its organs will continue unchanged and the matter is now closed.

**MEMBERS OF THE  
INTERNATIONAL COMMITTEE FOR WEIGHTS AND MEASURES**

As of 15 October 2015

**President**

B. Inglis, National Measurement Institute (NMI), Lindfield, Australia.

**Secretary**

J.W. McLaren, Ottawa, Canada.

**Vice-Presidents**

W.E. May, National Institute of Standards and Technology (NIST), Gaithersburg, United States of America.

J. Ullrich, Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany.

**Members**

B.R. Bowsher, National Physical Laboratory (NPL), Teddington, United Kingdom.

H.S. Brandi, *Instituto Nacional de Metrologia, Qualidade e Tecnologia* (INMETRO), Rio de Janeiro, Brazil.

F. Bulygin, All-Russian Scientific Research Institute for Metrological Service, Rosstandart (VNIIMS), Moscow, Russian Federation.

M. Buzoianu, National Institute of Metrology (INM), Bucharest, Romania.

I. Castelazo, *Centro Nacional de Metrología* (CENAM), Querétaro, Mexico.

Y. Duan, National Institute of Metrology (NIM), Beijing, China.

L. Énard, *Laboratoire National de Métrologie et d'Essais* (LNE), Paris, France.

M. Inguscio, *Istituto Nazionale di Ricerca Metrologica* (INRIM), Turin, Italy.

D.-I. Kang, Korea Research Institute of Standards and Science (KRISS), Daejeon, Republic of Korea.

T. Liew, National Metrology Centre, Agency for Science, Technology and Research (NMC, A\*STAR), Singapore.

W. Louw, National Metrology Institute of South Africa (NMISA), Pretoria, South Africa.

P. Richard, Federal Institute of Metrology (METAS), Bern-Wabern, Switzerland.

G. Rietveld, Van Swinden Laboratory (VSL), Delft, the Netherlands.

T. Usuda, National Metrology Institute of Japan (NMIJ/AIST), Tsukuba, Japan.

**Honorary members**

E. Ambler, Hilton Head Island, United States of America.

W.R. Blevin, Glenhaven, Australia.

L.M. Branscomb, La Jolla, United States of America.

J.V. Dunworth, Ramsey, Isle of Man, United Kingdom.

E.O. Göbel, Braunschweig, Germany.

K. Iizuka, Tokyo, Japan.

R. Kaarls, Zoeterwoude, the Netherlands.

D. Kind, Braunschweig, Germany.

J. Kovalevsky, Grasse, France.

J. Skákala, Bratislava, Slovakia.

## Agenda

1. Opening of the session, quorum and approval of the agenda
2. Confirmation of the minutes of Session I of the 104th meeting (9-10 March 2015) and list of decisions
3. Report of the Secretary and activities of the bureau of the CIPM
4. Update on the activities of the BIPM by the Director
5. Financial matters
6. The BIPM Pension and Provident Fund
7. Report from the CIPM *ad hoc* Working Group on Conditions of Employment
8. CIPM MRA review
9. BIPM Liaison and Communication
10. Report from the JCRB
11. Report from the CCU
12. Reports from the BIPM Chemistry Department, CCQM and JCTLM
13. Reports from the BIPM Ionizing Radiation Department, CCRI, CCAUV and CCT
14. Reports from the BIPM Time Department, CCTF and CCL
15. Reports from the BIPM Physical Metrology Department, CCEM, CCM and CCPR
16. Summary of the decisions made on membership and observership of the Consultative Committees
17. Report from the CIPM Sub-Committee on Awards
18. Report from the *ad hoc* Working Group on Terminology
19. Depository of the metric prototypes
20. BIPM workshops
21. Operation and frequency of future CIPM meetings
22. Any other business
23. Closure of the meeting

**SESSION II OF THE 104TH MEETING OF THE CIPM – FIRST DAY – 15 OCTOBER 2015****1. OPENING OF THE SESSION;  
QUORUM;  
AGENDA**

The International Committee for Weights and Measures (CIPM) held Session II of its 104th meeting on Thursday 15 and Friday 16 October 2015 at the International Bureau of Weights and Measures (BIPM).

Present: B.R. Bowsher, H.S. Brandi, F. Bulygin, M. Buzoianu, I. Castelazo, Y. Duan, L. Énard, B. Inglis, M. Inguscio, D.-I. Kang, T. Liew, W. Louw, W.E. May, J.W. McLaren, M.J.T. Milton (Director of the BIPM), P. Richard, G. Rietveld, J. Ullrich and T. Usuda.

Also attending the meeting were: C. Fellag Ariouet (Personal Assistant to the Director and Head of the Secretariat and Housekeeping Office), C. Planche (Librarian/Drafting Officer) and R. Sitton (Publications Officer).

The following were in attendance for parts of the meeting: E.F. Arias (Director of the Time Department and Executive Secretary of the CCTF), H. Fang (Executive Secretary of the CCM), A. Henson (Director of the International Liaison and Communication Department), J.-M. Los Arcos (Director of the Ionizing Radiation Department and Executive Secretary of the CCRI), S. Picard (KCDB Coordinator and Executive Secretary of the CCAUV and CCT), T.J. Quinn (Emeritus Director), L. Robertsson (Executive Secretary of the CCL), M. Stock (Director of the Physical Metrology Department and Executive Secretary of the CCEM), J. Viallon (Executive Secretary of the CCPR) and R. Wielgosz (Director of the Chemistry Department and Executive Secretary of the CCQM and JCTLM).

Dr Inglis, President of the CIPM, opened the session. With all 18 members present the quorum was satisfied according to Article 12 of the Regulations annexed to the Metre Convention.

The agenda was approved.

Dr Inglis reported that Dr Seton Bennett, a member of the CIPM between 2002 and 2011, had died on 14 September 2015. He said that Dr Bennett had been a major contributor to all aspects of metrology and the CIPM. He would be greatly missed. Dr Milton had attended the funeral on behalf of the BIPM. The committee observed a minute's silence as a mark of respect.

**2. CONFIRMATION OF THE MINUTES OF SESSION I OF THE 104TH MEETING  
(9-10 MARCH 2015) AND LIST OF DECISIONS**

The minutes of Session I of the 104th meeting (2015) had been approved by correspondence and were accepted as a true record.

**Decision CIPM/104-27** The CIPM accepted the minutes of Session I of the 104th meeting of the CIPM as a true record.

The President reviewed the decisions from Session I. All were progressing as expected. The status of the following was noted:

**Decision CIPM/104-15** *The CIPM requested the CIPM bureau to convene a meeting with the Regional Metrology Organization Chairs and to report back.*

The meeting with the Regional Metrology Organization (RMO) Chairs had taken place on 12 October. A number of points had been discussed including the major issues facing each region, the best way to present metrology to stakeholders, improved collaboration between the regions and the CIPM and the effectiveness of the Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB). The RMO representatives had expressed their appreciation of the meeting and it was agreed that regular meetings would be organized in the future.

There were no further comments on the decisions from Session I.

### **3. REPORT OF THE SECRETARY AND ACTIVITIES OF THE BUREAU OF THE CIPM**

Dr McLaren, Secretary of the CIPM, presented his report (see Appendix 1). He stated that the content of his report has changed in order to avoid duplication. Some of the topics previously included in the Secretary's Report will now be covered in the Director's Report and the report of International Liaison and Communication. He said that a report of the activities of the bureau is now produced immediately after each meeting for rapid circulation to the members of the CIPM.

### **4. UPDATE ON THE ACTIVITIES OF THE BIPM BY THE DIRECTOR**

Dr Milton reported that Dr Alain Picard, the Director of the BIPM Mass Department from November 2010 to July 2015, had died on 21 August 2015 after a long illness. His funeral had been well attended by BIPM staff as well as by Dr Richard.

Dr Milton started by observing that the BIPM is changing and is finding new ways to respond to the challenges it is facing. It has responded to the current trend among Member States not to grant increases in funding to international organizations, due to the current global economic situation, by developing new approaches to its funding. Following discussions on the proposed Visitor Programme, which had been submitted to the 25th CGPM but was not funded from the dotation, the CIPM had agreed to the 'Capacity Building and Knowledge Transfer Programme' at its last session in March 2015 and there have already been substantial successes in this area which will be reported later in the agenda.

Further advances have been made in increasing transparency and access to the work of the BIPM. The BIPM has made its first two webcasts, the amount of information available through the website is increasing and a new finance system is being put in place that will allow easier and more accurate reporting of financial information to the CIPM.

Two other major issues are being addressed but have not yet been completed. The first is ensuring the long-term financial sustainability of the Pension Fund. This is a complex issue of great concern to the BIPM staff, who have been heavily involved in the discussions. Dr Milton commented that he has

devoted a considerable amount of his time to this issue in 2015 and it is expected that this will continue until an agreement is reached in 2016. The second unresolved issue is tackling the large arrears of two Member States. The engagement with the Dominican Republic in this respect will be discussed later in the agenda.

The Director has been actively supporting the review of the CIPM MRA and this is expected to be a high priority item for the remainder of 2015 and 2016.

The Mass and Electricity Departments have been combined into a single Physical Metrology Department. The merger will lead to increased efficiency in the way the BIPM operates, with the Physical Metrology and Time Departments being housed in the Observatoire and the Chemistry and Ionizing Radiation Departments in the Marie Curie Building.

There have been five retirements since Session I: Dr Claudine Thomas (KCDB Coordinator), Mr César Neves (Principal Security Officer) and Ms Isabel Neves (Receptionist) on 30 June 2015, Mr Alain Picard (Director of the Mass Department) on 17 July 2015, and Mr Pascal Benoît (Principal Technician) on 7 August 2015. In addition, Ms Frédérique de Hargues (Secretary) resigned and left the BIPM on 10 July 2015. During the same period there have been three recruitments: Ms Johanne Flament (Secretary), Ms Phoulivanh Phoumavong-Sturel (Accountant) and Mr Jean-Luc Pilon (Electrician). Three further recruitments are planned and have been discussed with the bureau. The staff changes reflect the fact that the BIPM is moving towards more contract staff for support operations. For example, the reception and weekend site security are being handled successfully by contract staff and a support contractor was engaged to help with the IT security programme.

Dr Janet Miles has been appointed as the Executive Secretary of the Joint Committee for Guides in Metrology (JCGM) Working Group (WG2) on the International Vocabulary of Metrology (VIM) and Dr Joële Viallon has been appointed as the Executive Secretary of the Consultative Committee for Photometry and Radiometry (CCPR), taking over from Dr Stock. A new Executive Secretary of the Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV) is being sought.

Renovation work on the BIPM's buildings is ongoing. In the Observatoire this work has included the establishment of a new electricity laboratory and in the Marie Curie building a reorganization of offices and the creation of new laboratories has taken place. A new common coffee area has also been created in the latter. The issue of the BIPM being overcharged for electricity by its supplier in the period up to 2013 due to a malfunctioning meter has been handed to a lawyer in Paris. A refund is expected.

The recent emphasis of work in the IT team has been on improving security. New protocols will be rolled out towards the end of 2015 and the necessary hardware changes have been put in place.

Progress in the publications area included the sending of the Proceedings of the 25th CGPM to the printer on 5 October 2015, less than eleven months after the meeting. It was made available on the website in both French and English at the same time. The BIPM website has been expanded to contain more information and it is now fully searchable.

Two workshops were held at the BIPM in 2015: the Workshop on Measurement Uncertainty on 15 to 16 June 2015 and the Workshop on Global to Urban Scale Carbon Measurements on 30 June to 1 July 2015. The first sessions of both were broadcast as live webcasts. The talks from both of the first sessions are now available for download from the website. Dr Milton commented that he would like to receive feedback on the effectiveness of such webcasts.

Dr Milton recalled that he had travelled to Chinese Taipei and Malaysia during the week of World Metrology Day (20 May) and had attended the latest JCRB meeting held in Astana, Kazakhstan, in September 2015. During this visit to Kazakhstan, Dr Milton and Mr Henson met the Minister for Investment and Development and subsequently the Prime Minister, who was briefed on the

encouragement the BIPM has given to Kazakhstan as it develops its metrology activities. A delegation was received from the Dominican Republic on 21 September 2015. This will be discussed later in the agenda. A delegation from the United Arab Emirates is expected to sign the CIPM MRA in the near future.

World Metrology Day 2015 was aligned with the International Year of Light and was a great success. All metrics from the previous year have been exceeded. The theme in 2016 will be ‘Measurements in a Dynamic World’.

Future visits by the Director include to the Asia Pacific Metrology Programme (APMP) General Assembly in Beijing, China, in November 2015 and the Intra-American Metrology System (SIM) General Assembly in Punta Cana, Dominican Republic, also in November 2015. He is also planning to visit Saudi Arabia and Qatar in recognition of the progress being made by GULFMET.

Dr Milton noted that he will continue to be heavily involved in the review of the CIPM MRA, the timescale for which is likely to be reduced by three months, requiring extra work in the period up until the end of June 2016. The pension review will continue to be a very important commitment in 2016 and he acknowledged that he is indebted to Dr Bock and Mr Énard for their support at the meeting with staff on 25 September 2015. The third focus for the beginning of 2016 will be in delivering the new opportunities that will arise from the Capacity Building and Knowledge Transfer Programme, including the delivery of a workshop. Dr Milton thanked Mr Henson and Dr Wielgosz for the work they have already done towards expanding the BIPM’s opportunities in capacity building. There will be a Metrology Summer School in Varenna, Italy, in mid-2016 which would have a capacity building element.

Dr Milton concluded by remarking that the future of any organization lies with its staff. The opportunity to expand the work of the BIPM and to increase its impact is in the hands of its staff. In 2014 the BIPM received its largest donation of equipment in recent years and in 2015 a number of exciting projects and opportunities in capacity building have arisen, with several more under negotiation. These are new opportunities and they result from the hard work of staff at the BIPM. The opportunity to ensure that the BIPM’s finances are secure in the long term is also in the hands of its staff. Dr Milton noted that he is working directly with staff and will work through the proposed Pension Fund Advisory Board (PFAB) to agree a sustainable and affordable future basis for the pension fund.

The President thanked Dr Milton for his report and added that he had sent condolences to the families of both Mr Picard and Dr Bennett on behalf of the CIPM. He invited questions and comments.

Dr Bowsher commented that during recent discussions with colleagues at the NPL and the Designated Institutes in the UK in preparation for the CIPM meeting, it had been recognized that the BIPM is changing and that these changes are being noticed by the outside world. They also acknowledged that the BIPM is now more responsive to its stakeholders and there was praise for the work that Dr Milton and the CIPM has undertaken in this respect.

## **5. FINANCIAL MATTERS**

### **Report from the Chair of the CIPM Sub-Committee on Finance**

Dr Bowsher reported that the Sub-Committee had met twice since Session I, on 11 March and 13 October 2015. He noted that Ms Andernack, the Head of Finance, has been on sick leave for almost

two months, which has added to the Director's workload. The meeting on 11 March discussed the approval of the BIPM's 2014 accounts, which overall, were considered to be healthy. Revenues were higher than expected and there had been very good cost control, resulting in reduced expenditure. This gave a satisfactory EBIT of approximately 2.8 million €, although the liability for healthcare provision and other issues resulted in a loss.

The Pension Fund continues to be an issue and will be referred to in the formal accounts later in the agenda. There is now very professional management of the pension fund and Dr Bowsher echoed the comments of Dr Milton that the members of the CIPM Sub-Committee on the BIPM Pension and Provident Fund and Health Insurance have undertaken a considerable amount of work, particularly Mr Énard and Dr Bock. The actuarial work undertaken by Mercer has also been of great value. However, there has been an increase in the pension fund deficit of almost 50 million € to 116 million €. He commented that difficult decisions will need to be made that will affect the BIPM staff, such as increasing contributions to the fund and increasing the retirement age. These decisions are considered to be critical if the pension fund is to be made sustainable. The CGPM decision to pay an extra 150 k€ annually into the pension fund was discussed by the Sub-Committee and was a welcome contribution to the sustainability of the fund.

The Sub-Committee felt that an improvement is required in reporting up-to-date expenditure information that included all elements of expenditure such as e-purchasing, direct cheque payments and payments made in response to invoices for contracted services. It was felt that this could be addressed through the use of linked purchasing and accounting software that would prevent errors arising when performing manual corrections.

The Sub-Committee had discussed and agreed the proposed update to the financial regulations, which will be presented by the Director for approval later in the agenda. The update reflects the adoption of full accrual accounting at the BIPM and makes explicit reference to the current IPSAS standards that ensure transparency and accountability as well as optimizing value for money in the procurement of goods and services. The Sub-Committee recommends these changes for approval by the CIPM.

Some aspects of financial governance have been debated by the Sub-Committee, including revisiting some of the tasks that had been delegated to the Director. For example, major expenditures or contentious expenditures may require examination by the Sub-Committee or the Bureau as an additional approval step as part of good governance practice.

The final discussion undertaken by the Sub-Committee was the definition of the BIPM *point*. It recommends adoption of the draft recommendation on this subject later in the agenda.

### **Quietus for the 2014 financial reports**

The Director requested quietus for the audited financial statements of the BIPM and of the BIPM Pension and Provident Fund for 2014. The process of approving the statements had been carried out by correspondence (as agreed at Session I) and final unanimous support had been received in June 2015.

**Decision CIPM/104-28** The CIPM confirmed its approval of the audited financial statements of the BIPM and of the BIPM Pension and Provident Fund which it has approved by correspondence in June 2015. The CIPM gave the BIPM Director quietus for the 2014 exercise.

The Director reported on the budgetary situation for 2015. He explained that, in the absence of the Head of Finance, he had been supported by other members of the Finance team, for which he was very grateful. Operating expenses at 8 October 2015 were in line with the budget. Travel and transport costs were higher than budgeted, partly due to several relatively expensive offsite comparisons taking place in 2015. Laboratory expenditure was on track. Major capital expenditure included a new gas

chromatograph, a cryocooler, new microbalances and a robotic sample exchanger. Capital expenditure in the laboratories is expected to be below budget in 2015. Operating expenses for buildings were ahead of budget and capital expenditure was below budget mainly as a consequence of the major project for the Observatoire still being in the planning stage. This project is expected to progress in 2016. In summary, less had been spent than planned, due to the slower than expected capital spend. He invited questions.

It was recalled that the Director had previously mentioned that the future of any organization lies with its staff and, if this is the case, why is there no allowance for training or development shown in the budget. Dr Milton replied that the management of training had been reorganized so that each department now handles training from its own operating expenditure. Previously, all training had been managed centrally. The only cross-cutting training that remains in the BIPM's miscellaneous budget is language tuition. It was asked if the absence of the Head of Finance, Ms Andernack, from the BIPM for two months had caused any problems for the Director in terms of an increased workload and if the CIPM needs to take any action such as recruiting temporary assistance. Dr Milton replied that, although the Head of Finance was due back in early November, her absence has highlighted the need for a fully-integrated financial system. He went on to comment that the proposed new accounting software is needed following the expiry of the maintenance contract for the old software package. The new accounting software will be from the existing supplier and would incorporate more access to budgeting control information.

### **Value of the BIPM *point* for 2016 to 2019**

For the benefit of new CIPM members, Dr Milton explained that the BIPM *point* is an internal conversion factor that is used in calculations to correct salaries, allowances and pensions for inflation. Following the agreement of the BIPM dotation at the 24th CGPM and the Programme of Work for the period 2013 to 2015, the CIPM had considered and decided that the BIPM *point* be adjusted during the period 2013 to 2015 by a maximum of 1 % on an annual basis in recognition that the BIPM would have to operate within a budget increase of only 1 %. Previously, the BIPM *point* had varied with the Retail Price Index (RPI) and had been adjusted quarterly. The following decision was passed in June 2012:

*Decision CIPM/101-27: The CIPM approved the proposal that the point be adjusted temporarily during the period 2013-2015 by a maximum of 1 % on an annual basis.*

The Work Programme presented to the 25th CGPM and the associated budget were costed on the basis of the BIPM *point* not increasing by more than 1 % annually and Decision CIPM/101-27 expires at the end of 2015. Therefore, the CIPM was invited to approve the proposal that the BIPM *point* be capped at 1 % for the period of the next Work Programme for 2016 to 2019. There was a brief discussion and the proposal was approved.

**Decision CIPM/104-29** The CIPM approved the proposal that the BIPM *point* be adjusted temporarily during the period 2016-2019 by a maximum of 1 % on an annual basis.

### **Approval of the budget for 2016**

Dr Milton recalled that the budget for 2016 had already been submitted to the 25th CGPM as part of the detailed financial proposal justifying the work programme. However, the Metre Convention requires the CIPM to approve the budget for each year. He presented the budget. He noted that a detailed breakdown of staff costs into salaries, allowances and contributions would be provided when Ms Andernack returns and the figures will be provided to the CIPM Sub-Committee on Finance. The President thanked Dr Milton and invited questions and comments.

Dr Louw commented that there was a difference between the contribution to the pension fund shown in the budget for 2015 and the projected outturn for 2015. He asked why there was a discrepancy. Dr Milton

answered that as part of the plans proposed to the 25th CGPM to address the long-term sustainability of the pension fund, the BIPM would pay an additional 150 000 € into the fund each year. The BIPM is still some way from achieving this but some extra money is being paid into the pension fund and this accounts for the discrepancy. Dr Milton added that the figures are further complicated by the fact that the salary base is declining due to retirements and this affects the percentage contribution from salaries. It was queried why the estimated figure for staff salaries and allowances does not increase uniformly from 2016 to 2019. Dr Milton clarified that this is due to planned retirements and planned recruitments.

**Decision CIPM/104-30** The CIPM approved the budget proposed by the Director for 2016 (CIPM/2015-II-18), noting that he will provide further details of budgeted staff costs to the CIPM Sub-Committee on Finance.

### **Review of the BIPM Financial Regulations**

The Director commented that it is necessary to review the BIPM Financial Regulations every five years. The review was carried out in consultation with Ms Andernack and Dr Bowsher, who circulated the document to the CIPM Sub-Committee on Finance. He presented the document (CIPM/2015-II-15) and went through the proposed amendments. Noteworthy changes were that the Pension and Provident Fund will now be referred to as ‘the Pension Fund’ (Article 18). In the spirit of the BIPM’s commitment to transparency and accountability in all of its work, Article 24.2 has been amended.

The Director was asked to clarify what was meant by ‘significant’ in the sentence ‘*A full statement of all significant amounts written off shall be attached as an annex to the financial statement*’ in Article 28 on the ‘Writing off of loss of assets’. He commented that the auditor decides when a write-off is needed and what is considered to be significant. Under IPSAS rules, an asset is written off if it is no longer relevant to the business.

**Decision CIPM/104-31** The CIPM approved the proposed amendments to the BIPM Financial Regulations (CIPM/2015-II-15).

## **6. THE BIPM PENSION AND PROVIDENT FUND**

Mr Érard, the Chair of the CIPM Sub-Committee on the BIPM Pension and Provident Fund and Health Insurance informed the CIPM that the eighth meeting of the Sub-Committee had been held on 5 May 2015. He said that it had discussed the increase in the pension fund liability shown in the Annual Report, the governance of the proposed Pension Fund Advisory Board (PFAB), the election of a staff representative to the PFAB and the most recent studies from Mercer. It had also considered the comparative study of healthcare insurance against the French social security system that had been carried out by the *Commission assurance-maladie* (CAM). Following this meeting and a presentation by the Director to BIPM staff, the *Commission des conditions d’emploi* (CCE) sent a list of 27 questions about the pension fund to the Director in July. These were all answered in an open letter from the Director to staff in September (CIPM/15-II-09 No. 1).

The ninth meeting of the Sub-Committee was held on 25 September 2015. Dr Gérard Petit attended this meeting as a staff representative, following his election by the BIPM staff, to allow him to familiarize himself with the matter of pensions and actuarial studies and, after appropriate training, to be better prepared once the currently proposed PFAB is established by the CIPM. This meeting reviewed the plans

for the establishment of the PFAB and prepared the necessary documents for approval by the CIPM. Mr Énard noted that some internal rules of procedure for the PFAB, including a procedure for the election of a staff representative, will be drafted by mid-November. Following the decision of the CIPM, the PFAB will take over the activities related to the BIPM Pension Fund from the current Sub-Committee except that the health insurance activities will be transferred to the CIPM *ad hoc* Working Group on Conditions of Employment.

Mr Énard said that he had answered questions at the open meeting with all BIPM staff that had been held on the afternoon of 25 September 2015. The meeting had been organized by the Director and was also attended by Dr Bock as a representative of the Sub-Committee. The Director had distributed two documents before the meeting: the latest Mercer study and a summary of proposals for the revision of the BIPM Pension Fund, including a provisional timetable (CIPM/15-II-09 Nos. 2, 3, 4 and 5). The CCE presented the views of staff, which included 37 questions grouped into 13 different areas. Mr Énard observed that the meeting had been constructive and all the questions had been answered by the Director and the two members of the Sub-Committee. Following the meeting on 25 September, the CCE had sent a questionnaire to all staff to determine the most important issues and the guiding principles in the reform. These were received on 9 October 2015 (Document CIPM/15-II-09 No. 8). Since the meetings on 25 September, the Director had asked Mercer to study the financial impact of all eligible staff choosing to retire on a full pension after 35 years of service.

Mr Énard was asked if the Sub-Committee had looked into the situation around the world with regard to reversion pensions paid to younger partners. The Director commented that the BIPM is not currently following the practice in most other International Organizations. Mr Énard said that more advice was needed from Mercer regarding the reversion pension for younger partners and contribution scenarios for staff members who choose to work for more than 35 years.

The Director said that staff had asked about the concept of '*pénibilité au travail*' which allows staff members with physically demanding jobs to retire early. An initial review suggested that there were very few BIPM staff members who might be covered by such a rule and the costs to the BIPM would be very small.

Dr McLaren asked for more information about relatively young staff that wish to retire after 35 years of service and the current best practice in Europe. The Director replied that this is the question of maximum pension and is a major issue with staff. With the proposed increase in retirement age to 67 many staff might reach 35 years of service. A common practice is to allow individuals to work beyond 35 years of service whilst gaining no additional pension, but allowing the salary to increase. Mr Énard has suggested an alternative proposal similar to the practice of '*majoration*' that is followed in France. This allows further service to accrue to the pension in the period beyond 35 years but before the normal retirement age, although at a much reduced rate. There would need to be an actuarial calculation to ensure that this was equitable to both the scheme and the staff member. Dr Rietveld asked if staff members that choose to work beyond 35 years would receive an increase in salary followed by the pension being calculated on the average of the final five years of salary. The Director confirmed that this is the case.

The President commented that there had been a request from the CCE to have a representative at CIPM meetings during discussions on the pension fund. This had been declined. There had been a further request for a representative of an association of '*anciens*' on the PFAB. He asked for comments from the CIPM. Dr Rietveld noted that existing pensions are only affected by the value of the BIPM *point*. Dr Bowsher said that in normal circumstances, existing pensioners are not included in bodies that oversee pensions as they already have a contract that pays their pensions.

Dr Bowsher asked if the Member States could be approached to pay off the pension deficit followed by a move to a new defined-contribution scheme. The Director replied that the pension fund is not a capitalized scheme: it is being operated on a 'pay-as-you-go' basis. He added that he would like to have

an agreement in place before the next General Conference showing that staff have made additional contributions and that the situation with the pension fund is under control in the long term. Dr May added that existing staff who pay the pensions through the pay-as-you-go scheme have an interest and should be represented on the PFAB. He reiterated that existing pensioners are not stakeholders because their pensions are only affected by the *point*.

The Director stated that a series of decisions was needed. The first was for the transfer of responsibility for the BIPM Health Insurance scheme from the CIPM Sub-Committee on the BIPM Pension and Provident Fund and Health Insurance to the CIPM *ad hoc* Working Group on Conditions of Employment. The second was the establishment of a Pension Fund Advisory Board (PFAB) that will take over the responsibilities for pensions from the CIPM Sub-Committee on the BIPM Pension and Provident Fund and Health Insurance. There was some discussion about whether the PFAB is a permanent board. It was clarified that the Regulations and Rules of the BIPM Pension and Provident Fund make it very clear that the PFAB is a permanent Sub-Committee of the CIPM. It was also questioned if the CIPM *ad hoc* Working Group on Conditions of Employment, which is a ‘short-term’ Working Group, should be changed to become a ‘standing’ Sub-Committee. In this context, it was noted that the Terms of Reference for the appropriate Sub-Committees and Working Groups will be re-examined. The Director presented the proposed decisions for approval.

**Decision CIPM/104-32** The CIPM decided to transfer responsibility for the BIPM Health Insurance scheme from the CIPM Sub-Committee on the BIPM Pension and Provident Fund and Health Insurance (PF&HI) to the CIPM *ad hoc* Working Group on Conditions of Employment.

**Decision CIPM/104-33** The CIPM decided to establish a Pension Fund Advisory Board (PFAB) as described in the amended Rules and Regulations of the Pension and Provident Fund (dated 29 September 2015). The PFAB will take over the responsibilities of the CIPM Sub-Committee on the BIPM Pension and Provident Fund and Health Insurance (PF&HI) relating to pensions. It approved the amended Regulations in the English and French versions (both dated 29 September 2015).

Following the establishment of the PFAB, it was agreed that the existing CIPM Sub-Committee for the BIPM Pension and Provident Fund and Health Insurance should be closed because its mandate has finished.

**Decision CIPM/104-34** The CIPM decided to close the CIPM Sub-Committee for the BIPM Pension and Provident Fund and Health Insurance (PF&HI) and thanked its Chairs and members for their work.

The President asked the CIPM to appoint Mr Énard as Chair to the PFAB, Dr Bowsher and Dr Usuda as members, and Dr Bock as an external expert.

**Decision CIPM/104-35** The CIPM appointed Mr Énard as Chair of the Pension Fund Advisory Board (PFAB), and appointed Dr Bowsher and Dr Usuda as members.

The CIPM appointed Dr Christian Bock, Director of METAS (Switzerland), as an expert member of the PFAB and expressed its appreciation for the work he has performed as a member of the CIPM Sub-Committee on the BIPM Pension and Provident Fund and Health Insurance.

The President recalled the earlier discussion on the request from the association of ‘*anciens*’ of the BIPM to be represented on the PFAB. He noted that the Pension Fund is operated in a transparent manner and that the PFAB includes an elected representative from the active BIPM staff. Current staff have an interest in the rights and benefits that they will receive as pensioners because they are contributing through the pay-as-you-go scheme. Existing pensioners are only affected by the *point*. He concluded that

the CIPM did not consider it necessary to include a representative or observer from the association of 'anciens' on the PFAB at this time.

**Decision CIPM/104-36** The CIPM considered a request from an association of 'anciens' of the BIPM to have a representative or observer on the PFAB. The CIPM noted that it maintains a high standard for transparency with respect to the operation and financial status of the Pension Fund. It also noted that the PFAB now includes an elected representative of the BIPM active staff and that active staff have a natural interest in the rights and benefits that they will receive as pensioners. The CIPM therefore does not consider it necessary to include a representative or observer of the association on the PFAB at this time.

The Director commented that it is essential that the BIPM staff are made aware that the CIPM has thoroughly reviewed and debated the BIPM Pension Fund. Dr Louw stated that the discussions showed that the CIPM has the concerns and well-being of all staff in mind in its goal to achieve sustainability for the pension fund. Dr Bowsher reinforced this view by adding that it is important to feed back to staff, through the minutes, that the CIPM is trying to achieve a fair outcome that reflects their concern for the BIPM staff. The Director suggested the text for a possible decision on the issue. Following a discussion on the wording, the following was agreed.

**Decision CIPM/104-37** The CIPM reviewed reports and papers submitted by the CIPM Sub-Committee on the BIPM Pension and Provident Fund and Health Insurance and by the CCE of the BIPM relating to the proposals to reform the BIPM Pension Fund to address its long-term financial sustainability. The CIPM confirmed its intention that the Pension Fund be placed on a financially sustainable basis in order that it should be sufficient to support pension benefits in the long term. The CIPM requested the Pension Fund Advisory Board to progress the work started by the Sub-Committee.

## 7. REPORT FROM THE CIPM AD HOC WORKING GROUP ON CONDITIONS OF EMPLOYMENT

Dr McLaren, the Chair of the *ad hoc* Working Group, commented that no meetings had been held since the last session. Following decision CIPM/104-32 the Working Group has now been given the task of making suggestions on how to manage the sustainability of the BIPM Health Insurance scheme.

## 8. CIPM MRA REVIEW

Mr Henson and Dr Wielgosz joined the meeting and Mr Henson gave a brief report on the outcomes of the CIPM MRA Review workshop held at the BIPM on 13-14 October. He commented that one outcome of the workshop was the proposal to establish a Working Group on the Implementation and Operation of the CIPM MRA. Mr Henson discussed the proposed Working Group, which will have 18 members, and noted that it will include a support team, including the Presidents of the Consultative Committees of the CIPM (CCs) and the BIPM key comparison database (KCDB) staff. The proposed 18 members will consist of the CIPM President as the Chair and would include representation from across the RMOs. It

was suggested that the Working Group could be supplemented with additional members if other expertise is needed.

The President commented that the timetable for the review aims to send a draft report (with recommendations for action) to all NMI Directors three months before the NMI Directors meeting to be held in October 2016. It was suggested that the current timetable for the review should be revised and that work should start immediately taking into account the considerable amount of work that will be required to meet this target.

Dr Rietveld suggested that in order to move forward with the review the Working Group could be divided into sub-groups. Under the draft Terms of Reference for the Working Group there are six objectives. These could be clustered into three groups of two objectives for assignment to the sub-groups. Each sub-group could start work as soon as possible to prepare draft material ready for the first meeting of the full Working Group in March 2016. It was recalled that previous division of work among sub-groups had improved the effectiveness of Working Groups and the efficiency of subsequent meetings.

Dr Milton picked up on this point and commented that the objectives outlined in the draft Terms of Reference for the Working Group could be re-clustered. Objectives 1 and 2 broadly address the same issues namely 'To collect and summarize key expectations for the MRA and for its future development' and 'To capture the key strengths and weaknesses of the MRA and of its supporting documentation'. Objectives 4 and 5 'To consider whether there should be more "top-down" governance (by the CIPM or another group mandated to do so)' and 'To review the role of the JCRB in the governance and operations of the MRA' can be clustered as can objectives 3 and 6 'To formulate guiding principles for further improvements including to the overall hierarchy of key comparisons – CMCs – services' and 'To consider whether processes for the review, approval and uptake of CMCs could be improved'. He added that objectives 1 and 2 are almost complete following the discussions at the Workshop held on 13-14 October 2015. A summary of material presented at the workshop related to objectives 1 and 2 will be drafted and circulated to the Working Group as an introductory document. Dr Inglis commented that he will coordinate this task as the Chair of the Working Group and that the work already undertaken on these objectives during the workshop will allow the Working Group to focus on objectives 4, 5, 3 and 6 in that order. Dr Inglis added that the division of these four objectives between sub-groups will be considered. It was recalled that the workshop had discussed how to make the CIPM MRA sustainable for the future, rather than just looking at the issues that affect it now. With this in mind, the question was asked if the Working Group will look at projections for what might happen in the future and how to respond. Dr Milton replied that the review will investigate how the CIPM MRA can progress and be effective on a five, ten and fifteen year horizon.

Dr Bulygin asked if there is a method for evaluating the efficiency of existing Calibration and Measurement Capabilities (CMCs), possibly by using key performance indicators, to assess progress. Mr Henson replied that analyses are available for the data in the KCDB. Dr Bowsher commented that he considered the spirit of the discussions at the CIPM MRA Review workshop to have been positive and there was an overall impression that the NMI Directors wanted to work constructively to improve the CIPM MRA.

Dr Wielgosz commented that he had been surprised that the NMI Directors had not made more presentations on the percentage of their annual budgets spent on the CIPM MRA with a breakdown of the cost and whether that amount is at the right level or not. He added that the NMIs often mention that they are involved in too many comparisons and meetings. However, because this was not mentioned during the workshop, he had concluded that the level of resources applied to the CIPM MRA must be about right. He was of the opinion that in the case of chemistry, although the CCQM organizes a lot of comparisons and meetings, these are worthwhile. Dr May said that although there had not been a

discussion on this subject during the workshop almost every NMI has a growing chemistry and biology programme and if the BIPM wants to remain relevant in the 21st century, it must be active at these new frontiers in metrology. Dr Wielgosz clarified that he was not talking specifically about chemistry; he was talking about quality infrastructure in general and how much an NMI should be spending on the CIPM MRA. Comments during the workshop indicated that about 5 % of NMI budgets are spent on work related to the CIPM MRA. He added that the review should look at how much the CIPM MRA costs, is the money spent in the right areas and is it efficient?

Dr Louw commented that the NMISA had considered it to be too difficult to calculate the cost of the work it carries out in relation to the CIPM MRA. He added that in terms of the cost of a quality system, South Africa has legislated that traceability must be carried out by an accredited facility, so the NMISA has no choice in being third party accredited. To calculate the costs of the CIPM MRA they focused on how much it would cost to determine comparability if the CIPM MRA did not exist. The conclusion was that the CIPM MRA is essential and the NMISA should investigate how to do the work as efficiently as possible. His impression from the workshop had been that the efficiency of the CIPM MRA, particularly key comparisons (KCs) and quality system review should be examined. Speaking as a CC President he felt that the strategic planning of KCs could be improved. Dr Louw commented that the approval process for CMCs should be examined to determine if there is a level of CMCs, possibly for less complex services, which do not require the same level of rigour. The review could investigate quicker and more efficient ways to publish such CMCs. He finished by adding that the review should look into the issue of improving the way that stakeholders can access CIPM MRA services.

Dr Rietveld commented that although the VSL, the Netherlands, has to participate in the CIPM MRA, the 7 % of its budget that it spends on these activities could be reassigned to other services, especially at a time when the overall budget is under pressure. He suggested that the ideal situation would be to retain the current benefits but at a reduced cost. Dr Ullrich added that the PTB, Germany, had not calculated the cost to it of the CIPM MRA but there is an internal feeling that there is a limit to the amount it can spend. He added that the efficiency of the CIPM MRA needs to be improved at the same time as reducing the impact on the NMIs. The PTB has reduced its participation in KCs in an attempt to reduce costs. He went on to suggest that after the review of the CIPM MRA is complete and the KCDB has been overhauled, a newsletter detailing new CMCs could be initiated to raise the profile of the database among its stakeholders. Mr Henson pointed out that a 'What's new' KCDB page is already available on the BIPM website.

Dr Buzoianu asked about the amount of effort required to maintain CMCs in the KCDB, how to make the CIPM MRA more visible to the outside world and the way in which the ILAC P10 document is implemented. Mr Henson replied that the ILAC policy calls on all accredited laboratories to obtain traceability to the SI either by first going to another accredited laboratory or to the CIPM MRA, so the MRA is the first building block it calls on to provide traceability to its 50 000 accredited laboratories.

Dr McLaren recalled the earlier discussions and commented that he was unclear on the difference between a 'high-level' and 'low-level CMC'. He added that what is relevant is whether a CMC is 'fit-for-purpose'. Dr Louw commented that within AFRIMETS there are many institutes that aspire to publish a CMC that are struggling to do so. He ventured the opinion that the CIPM MRA has been used to 'market' metrology and in a sense CMCs have become a 'commodity'. As a consequence governments may give funding to a laboratory but insist that it must get to a point where it has a CMC. Also, within Africa there is a considerable amount of intra-regional trade and free trade areas (FTAs) are being formed. As a result, there is a need to find a way to demonstrate the competence of institutes to facilitate intra-regional trade within a FTA. The President noted that in his discussions with some of the NMI Directors it became clear that government funding for their NMIs had come under pressure following a reduction in their CMCs.

Dr May commented that there had been an emphasis on CMCs when there should have been an emphasis on improvements in the capability to make measurements that could deliver 'fit-for-purpose' services. From a business perspective, usable and tangible services are more important than the number of CMCs. The drive to publish more-and-more CMCs has commoditized them to the extent that some NMIs may simply generate more CMCs to achieve government funding. The President added that the number of CMCs has become a simple metric for governments to use when assessing progress. Dr Liew commented that his experience within APMP had been that new NMIs do not always understand the meaning of a CMC, why they should have them and how they should relate to the services they can provide.

There was some discussion on the best way to compare and to assess the competence of NMIs rather than relying on the number of CMCs. Suggestions included the number of times an NMI acts as a pilot, the impact of an NMI's measurement programme on society and defining a new category of measurement capability, for example Calibration and Measurement Service. The latter could be at a lower level than a CMC and could be used for intra-regional trade. The specific services could be agreed within individual RMOs and the review process could also be less rigorous than for CMCs.

The President thanked the CIPM for their contributions and said that they would be relayed to the Working Group on the Implementation and Operation of the CIPM MRA.

## 9. BIPM LIAISON AND COMMUNICATION

Mr Henson reported that the French Foreign Ministry had advised that Lithuania and the United Arab Emirates had become Member States on 16 April and 27 April 2015 respectively and that there were 57 Member States as of 15 October 2015. He commented that Lithuania was the first Associate to progress to becoming a Member State through the 'escalator' mechanism (see Resolution 4 of the CGPM (2011)). He reported that Venezuela has already been in arrears for three years and the BIPM has been unable to establish effective contact with the appropriate authorities either in their Embassy or in Venezuela. If its contribution for 2015 is not settled by 31 December 2015, its arrears will have to be redistributed to the other Member States. However the situation may still not be known definitively in mid-December 2015 at the time the 2016 Notification is issued.

Sri Lanka has contacted the BIPM to explain that the situation that led to its exclusion on 31 December 2014 had been compounded by problems with internal communications caused by the routine rotation of staff at its Embassy in Paris. Mr Henson was further advised informally that Sri Lanka hoped that it will clear the outstanding unpaid subscriptions and re-join as an Associate in the future.

There are three Associates that have not settled their subscriptions for three years and are at risk of exclusion: Jamaica, Namibia and Ukraine. They have a combined debt of 200 k€. There have been extensive discussions with the Ukraine, which accounts for a significant proportion of this amount. Following these discussions, the BIPM received a formal letter from the European Union which has agreed to pay all three years of outstanding subscriptions for the Ukraine, under the terms of its support agreement for the country. Informal and formal notifications have been sent to Jamaica and Namibia which collectively have debts of 110 k€ for the three years. Whilst there have been encouraging informal discussions, so far there has been no formal response to the notifications.

Bosnia Herzegovina will have been an Associate for five years on 15 June 2016. It has already published CMCs and as such will trigger the established criteria and consequent CIPM discussion that is likely to

lead to formal encouragement to accede. If it chooses not to accede, then in 2018 it will enter onto the first step of the Associate State 'escalator' mechanism for its subscriptions.

World Metrology Day 2015 was very successful. It has become a major forum to raise awareness of metrology, particularly in countries with emerging metrology systems. Preparations have started for 2016 with a partner NMI (VNIIMS) in Russia. The theme for 2016 is 'Measurements in a Dynamic World'. In 2017, the NMI that will support the development of the poster will come from the SIM region.

Mr Henson commented that there has been a significant improvement in the time taken to publish and distribute reports of CGPM meetings. There was a delay of 32 months between the 2007 meeting and distribution of the report. This was reduced to 16 months for the 2011 meeting and 11 months for the 2014 meeting. He added that it may not be possible to reduce this period much more although ways are being investigated to reduce the overall size of the report.

### **Status of the Dominican Republic**

Dr Milton gave the CIPM an update on the situation regarding the Dominican Republic, including the background to their exclusion. The Dominican Republic acceded to the Metre Convention in 1954, ceased payment of its contribution in 1962 and had its advantages and prerogatives suspended in 1966. Following Resolution 7 of the CGPM (2011) a Rescheduling Agreement had been concluded with the Dominican Republic on 1 August 2012 for an annual payment of 57 536.17 € for 20 years as a settlement of its arrears, in addition to payment of the yearly contribution. They were excluded on 1 January 2015 for breaching the terms of this Rescheduling Agreement. Following their exclusion, two payments totalling 113 106.17 € were received in April 2015. As a result, correspondence has resumed with the Dominican Republic and a delegation was invited to attend a meeting at the BIPM on 21 September 2015 to discuss their request to restore their membership. The Dominican Republic also formally questioned the amount of debt owed to the BIPM, citing the six year exclusion clause in the Metre Convention. The meeting was attended by the Minister of Industry and Trade of the Dominican Republic, the Director of its NMI, representatives from its Embassy in Paris and a representative from the PTB and they expressed an interest in re-engaging in the work of the BIPM. Dr Milton commented that although they have been excluded, particularly given their demonstration of good faith in making payments of debt in 2015, it was obviously important to continue to work with the Dominican Republic to try to resolve the outstanding issues. It was proposed that a Memorandum of Understanding (MoU) would be developed to formalize the contact between the two parties. The MoU would acknowledge the fact that the Dominican Republic is no longer a Member State, that it had expressed its desire to re-engage, that it had questioned the validity of the 40+ year debt, and that this issue of the debt could only be dealt with by the Member States at the 26th CGPM, and finally that such a discussion would require prior preparation by both parties. The draft MoU has been sent to the Dominican Republic's embassy, but had not been signed as of 15 October 2015. Dr Milton advised that a similar discussion now applies to both the Dominican Republic and the Islamic Republic of Iran.

It was asked if the MoU will allow the Dominican Republic to attend the 26th CGPM as observers. Dr Milton replied that they will not have the right to attend because they have been excluded. However, he added that the President has the right to invite them as guests but, if invited, they would not have a voice at the meeting. In this respect their situation is different to Iran, which is still a Member State and has the right to attend the 26th CGPM. There was a discussion on whether asking States with significant arrears to pay back decades of debt that had accumulated while their rights and privileges had been suspended, while they received no services and were unable to participate, is ever going to be successful. Dr Milton concluded that rescheduling agreements that require the repayment of significant amounts of money are never likely to be a successful strategy and that this will be discussed at the 26th CGPM.

### **Progress with the 'BIPM Capacity Building and Knowledge Transfer Programme'**

Mr Henson presented the background, objectives and current status of the BIPM Capacity Building and Knowledge Transfer Programme (CB&KT). He recalled that at the 25th CGPM, a proposal for a BIPM Visitor Programme had been tabled, but not funded. However there had been sufficient interest to amend the draft Resolution on the Dotation of the BIPM thus: '[the CGPM] urges Member States, as well as international organizations, private organizations and foundations to maintain the provision of additional voluntary support of all kinds to support specific BIPM mission-related activities, *particularly those that facilitate participation in the activities of the BIPM by those countries without well-developed metrology infrastructure.*' He commented that any future new Member States and Associates will have emerging metrology systems and this will put an extra burden on the existing Members and that the majority of the work of operating the CIPM MRA falls on a disproportionately small number of 'larger' NMIs. The ideas behind the proposed Visitor Programme were further refined after the CGPM and a new voluntarily funded 'BIPM Capacity Building and Knowledge Transfer Programme' has been developed. The objectives are to assist individual NMI staff, NMIs and RMOs to increase their understanding and capability with regard to engagement in the global metrology system, with the aim of strengthening the capacity of the international metrology community to operate the world-wide measurement system on an equitable cost-shared basis; and to embed metrology more effectively in wider quality infrastructure development initiatives.

Mr Henson commented that, aside from the obvious challenge of finding sponsors, there is an advantage to not having a formally funded programme in that it allows greater flexibility. The BIPM can talk to sponsors and recipients and tailor solutions to meet the requirements of both, providing that they satisfy the broad objectives of the programme. This is referred to as the 'menu approach' and it allows donors to decide the actions they wish to support in consultation with the BIPM, and for example whether it should be open to Associates and whether to focus on supporting particular regions.

The programme has been discussed at the COOMET, AFRIMETS and EURAMET General Assemblies. Formal resolutions supporting participation in the programme were passed by the first two and EURAMET referred the matter to its focus group and positive discussions are ongoing, including whether the BIPM Capacity Building and Knowledge Transfer Programme can be linked to the capacity building section of EURAMET's European Metrology Programme for Innovation and Research (EMPIR).

The BIPM submitted a successful proposal for a US Government Grant, via NIST. The proposal was entitled 'BIPM Capacity Building and Knowledge Transfer for NMIs with Emerging Metrology Systems' and the contract has been signed for US\$ 213 000. The grant will allow the BIPM to run two training courses for a total of 30 metrologists from emerging NMIs in implementation and leadership for the CIPM MRA. The 11-day courses will be held in 2016 and 2017 and will be tailored for two groups: Course 1, 'Leaders of tomorrow' - training for the next generation of Technical Committee (TC) and WG chairs, and piloting comparisons; and Course 2, - 'A sound beginning' training to submit successful CMCs. A common theme for both courses will be 'hitting the target' i.e. training in techniques to ensure that CMCs under development are of greatest benefit to stakeholders. The RMOs were notified at the JCRB meeting in September 2015 that they will be solicited to nominate potential candidates for the training and for experts that could teach part of the courses. The NIST grant will cover full travel and subsistence for the trainees. The potential benefits of both courses to the participants and their NMI as well as to NIST and the wider regional (RMO) and world-wide metrology community were outlined.

Mr Henson added that support has been agreed in principle from METAS, Switzerland, for selected candidates from countries with emerging metrology systems to attend the joint BIPM/Italian Physical Society Metrology Summer School in Varenna, Italy, in 2016 and to undertake a short project-based

placement at METAS. Discussions are also under way with the Technical Cooperation Group of PTB, Germany, for possible support actions related to the programme.

Dr Wielgosz continued the presentation by talking about plans for a 'Mycotoxin Metrology Capacity Building Programme'. He gave the background to the programme by highlighting that according to Food and Agriculture Organization (FAO) estimates, 8 % to 18 % of cereals are lost during postharvest handling and storage, the majority being due to fungal growth and contamination with toxic metabolites of fungi, known as mycotoxins. He cited an example from Kenya in 2004 when 125 people died from eating maize or maize products that had been contaminated with mycotoxins. Over 100 countries have implemented regulatory limits for mycotoxins in food and feed to protect their populations from contaminated food grown in their own countries or from contaminants in imported food. AFRIMETS identified the regional need for certified reference materials to support its mycotoxin in food analysis requirements and brought the issue to the attention of the BIPM. For developing economies, creating a measurement infrastructure for mycotoxins is essential to protect a country's population and also to ensure that exported food is not contaminated.

The BIPM and AFRIMETS have worked together to develop a programme that will train scientists in the methods of analysis that the BIPM operates in-house and will give them access to value-assigned materials to help with their mycotoxin analysis programmes. The proposed programme will operate a new model for metrology capacity building, consisting of four stages with the BIPM as the hub. The first stage will involve characterization of pure mycotoxin materials, stock and calibration solutions. Stage two will entail knowledge transfer and comparison of capabilities for pure material, stock solution and calibration solution value assignment. The third stage will be the coordination of an international comparison of mycotoxin calibration solutions by the BIPM and the final stage will see the completion of capacity building and knowledge transfer with a self-sufficient group of NMIs that can support their own programmes for mycotoxins in food. The NIM, China, and the NMISA, South Africa, have committed total funding of 161 k€ to the programme and 3.5 years of visiting scientist time. Feedback from the NMIs has been very supportive and further commitments of funding and in-kind support are anticipated.

The impact of the mycotoxin metrology capacity building programme will be to increase the number of NMIs with know-how and experience of producing and value assigning mycotoxin calibrant CRMs, leading to a 'shortening of the traceability chain'. There will be improved access to calibrants for NMIs developing matrix CRMs for their regions as well as a strengthened measurement infrastructure for food analysis in the regions. The programme will also increase technical capabilities in the regions to support food exports and to protect home populations from the dangers of eating contaminated food.

It was queried what will happen when mycotoxin reference materials run out. Dr Wielgosz replied that the capability to produce future reference materials will be spread through more NMIs as they will possess the knowledge and methods after taking part in the programme. At the moment there are only a few sources of such standards. He added that the issue of having a measurement infrastructure for mycotoxins will be ongoing and will continue to be subject to regulations. The question of cost was also raised, especially considering the high cost of producing some of the standards. Dr Wielgosz commented that producing a high-quality product is expensive, but at the moment NMIs may have to pay a considerable amount for products that may be of questionable quality. The programme will raise the ability of NMIs to produce high-quality reference materials. Dr May added that although the cost is high if a NMI is producing a lot of material, in reality, a NMI may only need to produce a small quantity of a reference material to satisfy its own requirements, leading to a reduction in costs. Dr Louw added that an additional benefit of the programme is that it will foster greater cooperation between NMIs. He ventured the opinion that after the necessary equipment has been acquired to participate in the programme and the knowledge has been transferred, cooperation is expected to continue at a high level. Dr McLaren suggested that foreign aid agencies that are responsible for funding shipments of food to disadvantaged

countries could be approached for support, as the prevention of food spoilage in such shipments is an important issue.

## **Revisions of ISO/IEC 17025 and ISO GUIDE 34**

### **ISO/IEC 17025**

Mr Henson gave an update on the revision of ISO/IEC 17025 '*General requirements for the competence of testing and calibration laboratories*'. It is currently at the Committee Draft stage and is with the ISO CASCO national standards bodies for comment. The ballot closes on the Committee Draft on 24 November 2015. So far, of the six criteria set by the CIPM for the revision, all are broadly on target to be achieved. The most significant issue related to the CIPM criteria was preventing the document from becoming a 'conformity assessment standard' *per se* and this has been achieved. The non-normative reference to the GUM has been retained but, as expected, it was not possible to upgrade to a normative reference. There had been many negative comments about the GUM from the testing community, who consider it too complicated for their circumstances. Other more general issues also make the revision challenging, including the need to restructure the standard completely to follow a common ISO 17000 series process approach, issues related to whether standalone sampling be included or not, and the ISO desire to reduce detail and explanatory notes. Mr Henson added that a smaller drafting team will meet in Geneva, Switzerland, in January 2016 to discuss the comments on the Committee Draft of ISO/IEC 17025 and the next working group meeting will be held in Pretoria, South Africa, in February 2016. ISO/IEC 17025 is on target for publication in late 2017, providing it does not have to go to a second Committee Draft.

Dr Louw noted that not all NMIs have had much input into the revision process and they rely on the BIPM to give their views at the meetings of the ISO Working Group on the revision of ISO/IEC 17025. Dr Bowsher commented that some of his colleagues have expressed unease at the significant number of reviews of the GUM and the direction of some of the changes. Dr Milton replied that there had been around 1 000 comments on the GUM and these have been acknowledged. WG1 is discussing models on how to proceed in order to address the criticisms of the GUM.

### **ISO GUIDE 34 (ISO 17034)**

The Committee Draft of ISO 17034 has been approved, albeit with many revisions and the revised version of this will be sent out on 22 October 2015 for a three month ballot. The BIPM's comments on the original Committee Draft have been largely accepted and incorporated into the revised version. The international standard, ISO 17034, is expected to be ready for publication by mid-2016 if the draft international standard passes the ballot. ISO 17034 will have an impact on part of the traceability of ISO/IEC 17025.

## **10. REPORT FROM THE JCRB**

### **Progress towards the recognition of GULFMET**

Mr Henson reported that the JCRB, at its meeting held on 8-9 September 2015 in Astana, Kazakhstan, had unanimously recommended that the CIPM should consider provisional acceptance of GULFMET as a RMO within the meaning of the CIPM MRA. The JCRB considers that it has fulfilled the requirements for provisional acceptance outlined in §3 of document CIPM MRA-P-01 'Procedure for approval of the

entry of a new RMO to the JCRB'. It was agreed within the JCRB that the criteria of 'at least one NMI from the RMO (preferably two or more), shall have the technical competence required to participate in CC activities' is satisfied because its members have the ability to participate in relevant WG activities. The CIPM were reminded that provisional acceptance would allow GULFMET to gain experience by participating in the review processes (but without a vote), but would not allow them to review CMCs. To be granted full membership, GULFMET would have to wait a minimum of one year after being granted provisional status and also demonstrate fulfilment of all the requirements in §3 of document CIPM MRA-P-01. Mr Henson was careful to point out that the one year minimum wait was from the procedure, but considering the discussions in the JCRB and the still limited engagement and capability in some GULFMET members, care had been taken to make sure GULFMET understood this period should not be taken as an expectation.

There was a brief discussion where it was agreed that the best forum to gain the relevant experience for full membership is within the JCRB. It was commented that the presentations given by GULFMET at the JCRB possibly do not give a full picture of its capabilities. It is known that GULFMET has strong links with other RMOs and there are NMIs that are making significant contributions to its work, including KRISS, Republic of Korea, and UME, Turkey. Dr Kang confirmed that KRISS signed a MoU with GULFMET in March 2014 for experts from GULFMET to attend technical training courses. The CIPM agreed to grant GULFMET provisional acceptance as a RMO.

**Decision CIPM/104-38** The CIPM granted provisional acceptance of GULFMET as a Regional Metrology Organization (RMO) in accordance with the procedures of the JCRB and within the meaning of the CIPM MRA.

### Report from the JCRB

Mr Henson presented the actions and resolutions resulting from the 33rd and 34th meetings of the JCRB for information. The actions related to minor revisions to the policy documents CIPM MRA-D-02 and CIPM MRA-G-03 and a change to CIPM MRA-D-06 to give a more unified DI document which replaces JCRB-P-05 and CIPM/2005-07. Other actions were related to improvements in the implementation process, in particular the identification of key and supplementary comparisons that were started five or more years ago and have not yet reached a conclusion and the monitoring of CMC sets that have been in the status of 'review still in progress' for two years or more.

JCRB Resolution 34/1 and a series of actions related to reporting comparisons that involve participants who are non-signatories to the CIPM MRA were presented for discussion. JCRB Resolution 34/1: The policy for reporting comparisons that involve non-signatories to the CIPM MRA is clarified according to the following text: "*Measurement comparison reports should be written to reflect the experiment that was actually performed, including summary results from all participants. **These reports should be accessible from the online Key Comparison Database, but the graphs and tables of equivalence explicitly shown should include results only from signatory NMIs and DIs.** The results for non-signatory participants should be considered as evidence of metrological competence for any future CMC submissions in the event that the laboratory becomes a signatory to the CIPM MRA. Note: This would not apply to laboratories participating in a measurement comparison under less stringent rules than the signatory laboratories (e.g. as a 'pilot study' participant for a measurement comparison in chemistry).*" Mr Henson noted the current practice requires the redaction of non-Member State and non-Associate participants in RMO comparisons. This is problematic and requires the production of two reports, one redacted and one for local use. There had been unanimous support within the JCRB that such reports should simply be factual and should state who took part in the comparison. These reports are not currently published in the KCDB; they are published as *Metrologia Technical Supplements*. Dr Milton added that the practice for dealing with such comparisons is significantly different across the CCs,

highlighting the need for a meeting of CC Presidents to deal with such issues. He commented that JCRB Resolution 34/1 had been passed by the JCRB after lengthy and detailed discussions.

Dr Rietveld commented that within the CCEM and EURAMET the issue is not to do with NMIs that are from countries that are yet to become Member States or Associates, the specific issue it has faced is instances where a commercial laboratory wanted to join a key comparison. This would cause problems with such a laboratory potentially gaining a commercial advantage if it were to be part of published results in the KCDB. Dr May commented that the CCQM had developed the concept of 'Pilot Studies' which are separate to key comparisons. A pilot study is a laboratory based symposia that precedes a key comparison. It allows laboratories that are not signatories to the CIPM MRA to take part under strict rules for participation and the results are published anonymously. Participants cannot use the results for commercial purposes. Participation in CCQM key comparisons is restricted to signatories to the CIPM MRA that are members of the CCQM. Dr Milton added that JCRB Resolution 34/1 is concerned with key comparison reports; the JCRB is not concerned with pilot study reports, and the eligibility to participate in comparisons is at the discretion of individual CCs. Dr Louw commented that within the RMOs this issue is connected to NMIs and DIs that participate in key and supplementary comparisons and which are members of an RMO but do not come from Member States or Associates. These participants may however be in the process of becoming Member States or Associates. Mr Henson added that the JCRB had several other actions for the BIPM to review procedural documents of relevance to JCRB Resolution 34/1 and to look at the current practice within the KCDB website of listing non-signatory participants in comparisons. The issue of listing non-signatory participants in the KCDB (as opposed to in the Comparison Reports) would be considered by the JCRB once the data had been gathered. He also noted that the JCRB had an action relating to the BIPM CB&KT, where the RMOs are to establish mechanisms to identify potential candidates to participate in the training programmes.

Dr Milton asked the CIPM to consider a formal decision to note that Resolution 34/1 had been discussed and that the CC Presidents will be asked to reflect on its implementation.

**Decision CIPM/104-39** The CIPM took note of Resolution 34/1 of the Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB) on the policy for reporting comparisons that involve non-signatories to the CIPM MRA and mandated the Presidents of the Consultative Committees to implement it.

### **KCDB update**

Mr Henson commented that there were 24 041 published CMCs in the KCDB as of 1 September 2015. The number of greyed out CMCs increased by 100 between April and September 2015 to 253. He noted that of the 40 Associates of the CGPM, only 22 had CMCs published in the KCDB as of 1 September 2015. On the same date there were 1348 comparisons in the KCDB, consisting of 915 key comparisons and 433 supplementary comparisons. Dr Milton commented that better harmonization is required between the CCs because the use of the terms 'key' and 'supplementary' is not consistent. This undermines the quality of the data as trends in the development of key comparisons cannot be accurately monitored if some CCs are referring to all new comparisons as 'supplementary'. Mr Henson noted his thanks to Dr Thomas for her many years of devoted service to the KCDB before her retirement in June 2015. He also thanked Dr Picard and Dr Maniguet for taking over the operation of the KCDB. The President extended the appreciation of the entire CIPM to Dr Thomas for her years of service and her role in making the KCDB the success it is today.

## 11. REPORT FROM THE CCU

### The SI Promotion Task Group

Prof. Ullrich presented the progress and current situation regarding the SI Promotion Task Group, which was set up under the auspices of the CIPM. An initial meeting of the task group was held at the BIPM on 21 July 2015 consisting of the heads of the public relations (PR) offices of the KRIS, LNE, NIST, NMIJ and PTB as well as Prof. Ullrich, representing the CIPM and the CCU, and Dr Milton, representing the BIPM. The structure of the task group, its terms of reference and membership were discussed at the meeting. It was proposed that the task group should be structured into two layers: an SI Promotion Task Group and a smaller PR Expert Group.

The SI Promotion Task Group would be chaired by a representative from the CIPM and would include representatives from the NMIs and the President of the CCU. The PR Expert Group would include a Secretary and three or four experienced press officers. The latter would develop plans and key messages that would be sent back to the SI Promotion Task Group.

Under its proposed terms of reference, the mission of the SI Promotion Task Group is to identify and develop key tools to promote the new SI among a wide range of different priority target groups and to identify and develop specific communication tools and messages for each target group. Its duties would involve commenting on the work of the PR Expert Group, ensuring that materials can be used in different cultural contexts and in different languages and presenting to the CIPM.

The work of the PR Expert Group would include: conducting a gap analysis of available materials and tools and the preparation of a work plan based on priorities; to contribute to the development of communication materials and tools prepared by the PR Expert Group. It will meet up to three times a year in 2016 and 2017. Prof. Ullrich presented a timetable, noting that the first meeting of the PR Expert Group will be held at the BIPM on 9 to 10 November 2015, with the first official meeting of the Task Group scheduled for 21 January 2016. He commented that approval is needed from the CIPM for the suggested structure and composition of the Task Group and Expert Group as well as the proposed terms of reference. The CIPM should also nominate a Chair for the Task Group.

The President thanked Prof. Ullrich and invited questions and comments. It was observed that the Task Group intends to inform the public that the changes to the SI will not have any direct practical impact on them; however this appears to contradict the efforts suggested here. This issue needs to be reconciled and consistency is needed in the message that is to be disseminated. There was a suggestion that the promotion campaign should not just focus on the changes to the SI, it should also emphasize the benefits of the redefinitions in everyday life. Prof. Ullrich replied that this is core to the work of the Task Group. It was noted that in the material presented there was no specific mention of governments and industry among the target groups. The Task Group should help to empower NMIs to engage with industry and governments, not just the general public and the scientific community, in order to provide reassurance about the potential benefits of the redefined SI in the future. It was noted that engaging with governments early in the process will help with adoption at the 26th CGPM. Prof. Ullrich agreed that this was a valid comment and it will be addressed at the next meeting of the Task Group. He asked the CIPM to send him any comments directly. Concerns were raised about the suggestion that the PR Expert Group should meet up to three times a year and the burden this would place on those involved. Prof. Ullrich noted that although face-to-face meetings are important, much of the work of the Group could be carried out through virtual meetings.

Dr Rietveld commented on the link with the CCs, noting that the CCEM will be specifically affected by the redefinition through the introduction of small step changes in the electrical units that are disseminated using Josephson and quantum Hall standards. These changes will be visible in laboratories working with

the smallest uncertainties. The CCEM Working Group on Proposed Modification to the SI (WGSI) was set up in 2013 to handle the effects of the redefinitions and it has revised its terms of reference to include PR activities. Prof. Ullrich commented that the efforts being undertaken by the CCs in terms of PR should be aligned. It was agreed that the CCEM should be represented on the Task Group.

Dr Milton commented that the message for each of the target groups is different and will have to be tailored for their specific needs. The overall message is that measurements that are traceable to the SI are stable and that our stakeholders in wider society are 'in good hands' because the NMIs will continue to do a good job and keep them stable. For the general public this should be extended to form a message that there will not be any change in the measurements that they encounter in everyday life. The promotional efforts need to convey this reassurance whilst introducing the fact that the changes are scientifically interesting and useful. The PR efforts also represent an opportunity to promote metrology in general. Dr May added that NIST has started its PR campaign and is initially targeting younger people.

There was a brief discussion on whether it is appropriate to continue using the term 'New SI', when the SI will essentially remain the same after the 26th CGPM but with new definitions. It was agreed that any decision on 'branding' should be left to the PR Expert Group. Prof. Ullrich finished his presentation by presenting a recent news article that was published in *Nature* entitled '*Experiments to redefine kilogram converge at last*' (*Nature*, **526**: 305-306). He noted that the paper gave welcome publicity to the work that is going on towards the redefinitions and included a reference to the current CIPM meeting. He suggested that the CIPM could issue a press release or note after its meetings giving an update on the current position of the work on the redefinitions. The President said that this was a good idea in principle, but care would be needed so that decisions are not pre-empted. He added that it would need to be clear as to what message should be sent out and that it is consistent. Dr Milton added that the principle of a press notice is reasonable, but that the CIPM communicated via its decisions. Any message that is sent out needs to be shared with the CCEM and CCM as well as the CCT and CCQM, all of whom are involved. It had previously been agreed that the process for the definition was via the CCs and then the CCU, which would feed decisions back to the CIPM. This process should not be short-circuited.

The President asked if there were any further comments on the structure, composition and terms of reference of the SI Promotion Task Group and the PR Expert Group. He also commented that a Chair was needed for the Task Group and proposed Prof. Ullrich. There were no further comments and Prof. Ullrich was selected.

**Decision CIPM/104-40** The CIPM welcomed the work carried out by the Consultative Committee for Units (CCU) on the structure, composition and terms of reference of the SI Promotion Task Group and the Public Relations Expert Group. It nominated Dr Ullrich as Chair of the SI Promotion Task Group.

### **Draft Resolution for the 26th CGPM**

Prof. Ullrich informed the CIPM about the latest version of a Draft Resolution on 'The International System of Units, SI' to be presented at the 26th CGPM. This version included a number of comments from the CIPM bureau. He commented that the Draft Resolution will propose use of the current set of seven base units. He added that each of the explicit unit definitions is rigorous and can stand alone, and that use of the controversial term 'fixing the magnitude' has been avoided. The base units have been maintained, but there is a clear hierarchy whereby the defining constants are central to the redefined SI. The Draft Resolution includes three appendices that give the definitions of the base units of the SI, abrogation of the former definitions of the base units and the status of constants previously used in the former definitions. Prof. Ullrich invited the CIPM to take note of the Draft Resolution before it is distributed to the CCU and the other CCs for their comments. He noted that it will need final approval by the CIPM before the 26th CGPM in 2018.

There was a suggestion that a footnote should be added to the Draft Resolution to state that after the redefinitions, the mass of the kilogram is being expressed using  $h$ . In response it was suggested that such information could be included in the explanatory notes that will accompany the Draft Resolution at the 26th CGPM. These explanations could include information on why the redefinitions were necessary and what was being changed. The formal resolution should be kept as succinct as possible.

Dr Milton commented that Appendix 1 emphasizes the consistency and the way the sequence of definitions ‘unrolls’ hierarchically. In this respect, he was surprised that in the definitions of the second, the kilogram, the ampere, the kelvin and the candela, the first reference is to a derived unit rather than to the unit that is being defined. He commented that it would be more logical to state for example in the second, ‘*when expressed in the unit per second, which is equivalent to the unit hertz*’. The logical sequence of the narrative is lost by using the hertz, joule and watt in the definitions when they have not yet been introduced. The definition of the kelvin is acceptable but the other definitions in Appendix 1 appear to be worded the wrong way round. One consequence is that the definition of the second can appear as if it is defining the hertz. Dr Rietveld agreed and added that the coulomb is included in the definition of the ampere even though it is not regularly calibrated. He suggested that an intelligent solution is required. Prof. Ullrich said that the comments had been noted for attention by the CCU.

Dr Milton pointed out that the Draft Resolution document contains the CODATA 2014 values. This could lead to serious questions in the future as to why the CIPM had looked at the values in 2015 when they were not the final values. Prof. Ullrich replied that although the values had been included, the Draft Resolution document is a working document and is not for public distribution. It had been brought before the CIPM at this time simply to get their opinions before it is passed to the CCU. It was suggested that the values be replaced with a placeholder such as ‘xxx’ to avoid any future problems.

Prof. Ullrich commented that the timetable for the revision of the SI Brochure is on schedule. He outlined the current status and the guiding principles for the revision and briefly commented on the new arrangement proposed for the chapters in the 9th edition. Dr Milton suggested that the draft 9th edition of the SI Brochure should be sent to the NMIs for comment, recognizing that their opinions are valued. This could be done by the BIPM, following the same process that was used to circulate the GUM in 2015. Prof. Ullrich agreed that this would be a good idea and said that the next meeting of the drafting team will be held on 19 to 20 January 2016. The draft could be sent for comment after this meeting.

**Decision CIPM/104-41** The CIPM welcomed the proposal of the Consultative Committee for Units (CCU) to circulate a draft of the 9th edition of the SI Brochure and a draft resolution for the 26th CGPM on the redefinition of the SI base units to the Consultative Committees and the National Metrology Institutes for comment.

### **Membership of the CCU**

Prof. Ullrich presented a proposal for revised membership criteria for the CCU. The membership currently includes up to seven NMIs, chosen on the basis of expertise and language coverage. He commented that the selection of the seven member NMIs of the CCU has been contested regularly. The current criteria (expertise and language) are not specific enough to unambiguously identify the relevant group of NMIs. It is difficult to define clear criteria to rank the expertise of the NMIs and to agree on the seven most important languages, for example, the SI Brochure has been translated into at least ten languages in the past. An increase in the number of NMIs that are members of the CCU is not desirable as the committee would become too large to work effectively. An alternative proposal to optimize available expertise would be to replace the seven NMIs with the CC Presidents as regular members of the CCU. He said the CC Presidents are highly respected authorities in their fields and, as a group, comprise the expert knowledge of the entire metrology community on units and their realization.

The CC Presidents can ensure that all the expertise from the NMI community flows into the work of the CCU and they usually comprise a well-balanced group with regard to countries, regions and language representation. The overall number of attendees at CCU meetings would be reduced since the CC Secretaries that were present as invited guests at the last CCU meeting would be replaced by the CC Presidents as regular members of the CCU. He noted that the existing participation by the International Unions, International Commissions or Committees, and other Intergovernmental Organizations or International Bodies which have a specific interest in units and which help to implement the recommendations of the CCU will not change.

The President thanked Prof. Ullrich and invited comments, particularly from the CC Presidents. There was an exchange of views and it was noted that the CC Presidents have an automatic right to attend all CC meetings. Dr Milton proposed a pragmatic solution whereby the existing membership criteria are retained, with the addition of three NMIs that have previously applied for membership (KRISS (Republic of Korea), METAS (Switzerland) and NRC (Canada)) as guests. He qualified this suggestion by commenting that reducing the size of the CCU on the eve of what could be a potentially historic decision to adopt the new definitions of the SI base units at the 26th CGPM in 2018 and replacing the NMIs with the CC Presidents as members of the CCU could send out the wrong message. There was consensus that this would be a good way to proceed as a temporary measure, however, there should be a full discussion on the membership criteria for the CCU at the meeting of CC Presidents in June 2016.

**Decision CIPM/104-47** The CIPM decided not to change the criteria for membership of the Consultative Committee for Units (CCU) and requested the CCU President to invite KRISS (Republic of Korea), METAS (Switzerland) and NRC (Canada) as guests. The CIPM noted that the Presidents of all of the Consultative Committees are welcome to attend meetings of the CCU. A full discussion on the criteria for CCU membership will be held in June 2016 during the meeting of the CC Presidents.<sup>1</sup>

## SESSION II OF THE 104TH MEETING OF THE CIPM – SECOND DAY – 16 OCTOBER 2015

The President welcomed the CIPM to the second day of its meeting, which was also joined by Dr Arias, Mr Henson, Dr Los Arcos, Dr Picard, Dr Quinn, Dr Stock and Dr Wielgosz.

### 12. REPORTS FROM THE BIPM CHEMISTRY DEPARTMENT, CCQM AND JCTLM

#### BIPM Chemistry Department

Dr Wielgosz reported on the activities of the BIPM Chemistry Department during the period 2013 to 2015 by focusing on eight key indicators of its outputs. There had been 56 NMI participations in comparisons organized by the department during the period; this number increases to 131 if reports finished during the period are included. The success of the department has been supported by the eleven visiting scientists who have worked on major projects between 2013 and 2015. This corresponded to five person-years of time and was equivalent to 500 000 € of extra investment from the NMIs in the BIPM chemistry programme. Nine papers have been published in peer-review journals, with another five in

<sup>1</sup> Decision CIPM/104-47 was taken later in the meeting and its number is out of sequence.

preparation. The department has brought in the equivalent of an extra 437 000 € via donations of NMR and GC-ECD instruments as well as funding for the JCTLM programme. Two new laboratory facilities have been established: a NMR laboratory and a greenhouse gas and carbon dioxide facility. The ozone cross-section measurements undertaken by the department were completed during the period and the capital investment from this programme was recycled into new projects on carbon dioxide. The department has contributed to the development of six international written standards, such as ISO Guide 34. A total of 14 meetings and workshops were organized between 2013 and 2015.

The chemistry programme has had a major impact in a number of areas. In terms of gas metrology, the ozone standards programme that started in 2000 with the NIST has seen a factor of ten improvement in the performance of ozone standards since then. Reference to the ozone key comparisons and recognition of their role in quality assurance of ozone monitoring around the world has been included in the World Meteorological Organization (WMO) 'Guidelines for continuous measurements of ozone in the troposphere'. The work on absorption cross-sections has been included in a WMO report on which cross-section should be used to measure ozone in the atmosphere, both at ground level and via satellites. The impact of BIPM measurements on regulatory compliance with air quality legislation has been reported in peer reviewed literature<sup>2</sup>. In terms of ozone monitoring, the 2 % change in the absorption cross-section was reported to result in a 20 % increase in the number of sites that would not comply with current US, Canadian, and European ozone air quality health standards for the year 2012. A Task Group has been set up in the CCQM Working Group on Gas Analysis (GAWG) to analyse all the measurements of absorption cross-sections for ozone and to develop a value that the community agrees as being the best for that parameter. Following agreement there will be wider consultation with the stakeholder community. The ozone programme demonstrates how a small-scale programme at the BIPM can have a major effect on world-wide measurements that impact everyday life. The BIPM has also led comparison activities on methane standards, with methane being the second most important greenhouse gas in terms of its contribution to atmospheric radiative forcing. The comparison had demonstrated a thirty fold improvement in the equivalence of methane standards since the previous comparison ten years ago, with the uncertainty in standards being lower than the yearly change in methane concentrations, and also providing data to allow adjustment of the WMO scale for methane in agreement with the SI values.

The BIPM's Small Organic Primary Calibrator Comparison Programme has resulted in a higher profile for metrology and traceability in organic analysis, with the publication of the paper 'Mass balance method for the value assignment of the purity of organic compounds' in *Analytical Chemistry* in 2013<sup>3</sup>. This paper had been cited 17 times as of October 2015. The International Union of Pure and Applied Chemistry (IUPAC) funded a BIPM and NMI led project to develop an international technical report. The project has also resulted in interest from instrument manufacturers thanks to assistance from the NMIJ, Japan, in developing measurement methods using a NMR instrument. This will result in new technology in the area of organic primary calibrators that will reduce measurement times from six months to one week.

The BIPM's Peptide Primary Calibrator Comparison Programme has included coordination of a key comparison (CCQM-K115) with the NIM, China, on C-peptide. This is the first key comparison on the purity of a peptide primary calibrator for a measurement system that can be used to differentiate between Type I and Type II diabetes. The LNE, France, is also supporting the BIPM programme with a six-month secondment to the BIPM to investigate the development of methods for cross-linked peptides (hepcidin) in preparation for future planned comparisons.

Dr Wielgosz briefly mentioned the increasing involvement of developing economies in the BIPM,

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<sup>2</sup>Sofen E.D., Evans M.J., Lewis A.C., Updated ozone absorption cross section will reduce air quality compliance, *Atmos. Chem. Phys.*, 2015, 15, 13627-13632

<sup>3</sup>Westwood S., Choteau T., Daireaux A., Josephs R.D., Wielgosz R.I., Mass balance method for the SI value assignment of the purity of organic compounds, *Anal. Chem.*, 2013, 85, 3118-3126

particularly the Mycotoxin Metrology Capacity Building Programme (see §9).

During the period 2016 to 2019 the Chemistry Department will continue its work on the measurement and value of clean air, particularly the measurement of nitrogen oxides (NO<sub>x</sub>). A key comparison (CCQM-K120) is being run in collaboration with NIST on carbon dioxide standards for both background and urban levels. The key comparison is expected to have 22 NMI participants, each having two to three standards. The carbon workshop held at the BIPM in June 2015 looked at the requirements for standards in these areas. Measurements now focus on determining the isotopic composition of carbon dioxide using laser-based spectroscopic instruments. By looking at the isotopologues it is possible to determine the exact source of the carbon dioxide. The CCQM has identified that a new comparison is needed on carbon dioxide isotope ratios. This was in the work programme of the BIPM, which has started discussions with the International Atomic Energy Agency (IAEA) to plan joint coordination of the new comparison. Isotope gases will be prepared by the BIPM and value-assigned by the IAEA. Further voluntary funding is being sought by the BIPM to acquire a magnetic sector mass spectrometer for gas stable isotope ratio work at the BIPM, to support the comparison programme. It is predicted that such an investment would attract visiting NMI scientists to the BIPM, who have already expressed interest in such a programme. Investment in this facility would support the long-term vision and strategy of the BIPM by allowing the development of a new programme and a long-term comparison programme in a key area.

In summary, the Chemistry Department has had a successful programme during 2013 to 2015 with a demonstrable impact, and in line with the CCQM strategy.

### **Consultative Committee for Amount of Substance: Metrology in Chemistry and Biology (CCQM)**

Dr May, President of the CCQM, spoke about how the CCQM looked for a programme at the BIPM that would complement the work of the NMIs. It chose one programme on gas analysis and another that focused on providing the underpinning metrological studies to support the provision of primary calibrators for organic analysis. He commented that the field of organic analysis is very broad but in order to provide traceability, high-purity references are needed. These are often not available in the NMI community. As a result, many laboratories were buying primary calibrators from a commercial source. This has two drawbacks: the quality of the material cannot be guaranteed and traceability is to that commercial source. The idea behind the CCQM programme was for the BIPM to lead a programme which would result in the NMIs providing fit-for-purpose primary references in organic analysis for their customers' calibration needs and to support their own traceability requirements.

The President thanked Dr Wielgosz and Dr May and invited questions. It was questioned how the sequestration of carbon dioxide is measured. Dr Wielgosz replied that 50 % of current global emissions of carbon dioxide are absorbed by the sea. If this was not the case, the increase in atmospheric carbon dioxide levels would be much greater and questions are being asked globally about what would happen, if at some point, oceanic absorption of carbon dioxide were to become less efficient. In an urban environment, the issue in relation to the regulation of carbon dioxide emissions is how to differentiate between industrial and natural sources. This requires accurate and precise isotope ratio measurements. Dr Liew congratulated the Chemistry Department on its work during 2013 to 2015, particularly on how this work has been relevant to its users, and for the engagement of international bodies. This has raised the profile of the work of the BIPM and its impact on society.

### Joint Committee for Traceability in Laboratory Medicine (JCTLM)

Dr Wielgosz commented that the JCTLM underpins the *in vitro* diagnostics (IVD) instrumentation sector that is worth \$80 billion world-wide and gave a brief summary of the joint committee's history and work. The JCTLM costs a total of 110 k€ annually to operate and the International Federation for Clinical Chemistry and Laboratory Medicine (IFCC) donates 50 % of these costs to the BIPM annually and has done so since the start of JCTLM activities in 2002. He commented that NMIs provide almost 100 % of the Certified Reference Material entries in the database, and the major users are Clinical Laboratories and the IVD industry. In 2016 a number of changes will be put in place. A modified Declaration of Cooperation document is being prepared and the JCTLM membership is being extended to include stakeholders, including the IVD industry. A revised Working Group structure will be put in place, which will include a new JCTLM database Working Group. A new Working Group on Traceability, Education and Promotion (TEP) will also be set up to increase awareness and impact of JCTLM activities in order to maintain funding from third-party sources, and to find additional funds for the work of the JCTLM through activities such as workshops. The TEP will take over the biannual meeting of JCTLM members where technical and logistical issues are discussed. It will also take over the scientific and educational meetings and symposia as well as producing promotional materials and the newsletter. The TEP will also produce and maintain a 'traceability' website. The next JCTLM members and stakeholders meeting will be held at the BIPM on 30 November to 1 December 2015. The agenda will include developments in traceability requirements around the globe, identifying future priorities and new challenges for traceability in laboratory medicine. The President thanked Dr Wielgosz and invited questions.

There was a question on the level of interaction with the Joint Research Centre Institute for Reference Materials and Measurements (IRMM). Dr Wielgosz replied that there is strong collaboration with the IRMM, which is the producer with the second largest number of reference materials in the database following the NIST, and that an IRMM official is the Chair of one of the JCTLM Working Groups. The IRMM views the JCTLM as an essential tool to promote its activities to the IVD industry. The JCTLM is also seen as part of a global initiative to ensure that the European IVD Directive is supported on a metrological basis. It was queried whether there is formal recognition by the EU that the JCTLM Database entries meet the requirements of the IVD Directive. Dr Wielgosz replied that it is not possible to get formal recognition, however providing that the materials, methods and services in the database meet the harmonized standards set by the EU, which are also the basis of the JCTLM review and acceptance process, the requirements of the IVD Directive have been met. The JCTLM therefore provides a third-party assurance that those materials meet the harmonized standards.

## 13. REPORTS FROM THE BIPM IONIZING RADIATION DEPARTMENT, CCRI, CCAUV AND CCT

### BIPM Ionizing Radiation Department

Mr Los Arcos gave an outline of the BIPM's activities in dosimetry and radioactivity in 2015. He commented that thermometry activities were discontinued during the year, although an internal consultancy service in thermometry will be maintained.

The BIPM's Dosimetry measurement activities are centred on: low-energy x-ray radiodiagnostic and mammography standards (BIPM.RI(I)-K2 and BIPM.RI(I)-K7 comparisons); medium-energy x-ray radiotherapy standards (BIPM.RI(I)-K3 and the upcoming BIPM.RI(I)-K9 comparison);  $^{137}\text{Cs}$  radioprotection standards (BIPM.RI(I)-K5 comparison);  $^{60}\text{Co}$  radiotherapy and radioprotection standards

(BIPM.RI(I)-K1, BIPM.RI(I)-K4 and BIPM.RI(I)-K8 comparisons); and high-energy photon beam (accelerator) radiotherapy standards (BIPM.RI(I)-K6 comparison). The Ionizing Radiation Department carried out seven comparisons during January to October 2015 and three more are planned before the end of the year. It has also carried out 18 calibrations of secondary standards and has published six reports. A new remote-controlled, intensity-monitoring assembly for the BIPM.RI(I)-K6 comparison has been developed, which allows improved reproducibility, radiation protection and time savings.

In the brachytherapy area, four results have been published and a new report is under way for the comparison carried out at the NMIJ in April 2015. The department has implemented a new travelling set-up for comparisons of standards for high-dose-rate (HDR)  $^{192}\text{Ir}$  sources using both thimble-type and well-type ionization chambers, which will allow the BIPM to cover each type of facility at different NMIs. Following the refurbishment of the Marie Curie Building, a new brachytherapy facility has been designed and is ready for implementation in early 2016. The facility will include a high-precision robotic arm to manipulate the reference source.

The results of the re-evaluation of  $W_{\text{air}}$ , a value that is essential for all primary ionometric dosimetry measurements were published in *Physics in Medicine and Biology* and have been discussed by the CCRI(I) community during the meeting in March 2015. An *ad hoc* committee is to be formed to discuss the timing for the implementation of the new value, following publication of the International Commission on Radiation Units and Measurements (ICRU) Report on Key Data.

A new absorbed-dose-to-water standard for medium energy x-rays has been developed. It is based on the existing free-air chamber and a waterproof transfer ionization chamber. A pilot study is under way with the PTB, and the results will be used to define the planned BIPM.RI(I)-K9 comparison.

Development of the SIR Transfer Instrument (SIRTI) continued in 2015. It will be extended to  $^{64}\text{Cu}$  with the first comparison planned at the NIST in 2016. In 2018 it will be further extended to  $^{11}\text{C}$ , which has a half-life as low as only 20 minutes. The pilot study for the extension of the SIR to  $\beta$ -emitters in 2015 has been postponed due to an irreversible breakdown of the balance. The pilot study has been rescheduled for 2016. The KCRVs of eight radionuclides have been updated during 2015 and a special issue of *Metrologia* 2015 **52**(3) has been published on 'Uncertainties in Radionuclide Measurements'.

### **Consultative Committee for Ionizing Radiation (CCRI)**

Dr Louw, President of the CCRI, said that its Sections and Working Groups had met during March 2015. Dr Malcolm McEwen, NRC, Canada, took over as the chair of CCRI(I) at its meeting. Two applications for observer status at the CCRI(I) were received: NIS, Egypt, and SMU, Slovakia. The Measurement Method Matrix developed by the CCRI(II) has been updated and a study is under way to determine if it can be better implemented and applied to the other two sections. The VSL, the Netherlands, has resigned as a member of the CCRI(II), SMU, Slovakia, has applied for full membership and the International Committee for Radionuclide Metrology (ICRM) has applied for observer status. The issue of how to accommodate the ICRM as an observer is under discussion. Dr Vincent Gressier, IRSN, France, has taken over as the Chair of the CCRI(III) and the Section has started looking at the definition of fields above 20 MeV with NMIJ and iThemba. The SMU, Slovakia, and iThemba LABS, South Africa, have applied for observer status at the CCRI(III).

Dr Louw commented that changes are planned to improve the efficiency of CCRI meetings. The meeting scheduled for 2017 will be reduced to 10 working days. Proposed changes include combining the KCWGs and shortening the CCRI(III) meetings, which may be held in parallel with the Section (I) and (II) meetings. The CCRI Sections will be operated like Working Groups, although the existing names will be retained. BSWG(I) and ESWG(II) will be closed when appropriate.

The President thanked Dr Louw and invited questions. Dr Milton welcomed the move from Sections to a Working Group structure and commented that in future he hopes that applications for membership and observership of the CCRI Sections can be handled by the CCRI rather than through the CIPM. The Secretary commented that Dr Louw's dedication to the leadership of the CCRI and his work towards the streamlining of the CCRI activities should receive particular recognition.

**Decision CIPM/104-42** The CIPM commended the Consultative Committee for Ionizing Radiation (CCRI) in its proposal to operate its three Sections in the manner of the Working Groups of the other Consultative Committees, whilst retaining the title "Section". Consequently, the CCRI is able to decide on the membership and observership of its Sections.

### **Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV)**

Dr Usuda, President of the CCAUV, commented that the committee had not met in 2014. Its next meeting will be held on 26 to 27 November 2015. Dr Usuda said that he had been appointed as the President of the CCAUV by the CIPM at its meeting in March 2015. The previous President, Prof. Valdès, had been invited to the NMIJ by Dr Usuda, to ensure continuity.

He added that the VSL, the Netherlands, has resigned as a member of the CCAUV and METAS, Switzerland, has applied to become a full member. A request for observer status by the CMS, Chinese Taipei, will be presented at the CCAUV meeting in November.

A half day seminar will be held on 25 November 2015 to celebrate the tenth meeting of the CCAUV. The seminar will include an invited talk on 'the hearing mechanism of insects' by Prof. Daniel Robert, University of Bristol, UK. Dr Usuda finished his presentation by commenting that the CCAUV is considering a focused issue of *Metrologia* on 'Dynamic Measurements'.

### **Consultative Committee for Thermometry (CCT)**

Dr Duan, President of the CCT, commented that it had not held a meeting in 2015. He began by recalling that, as had been mentioned earlier in the meeting, Mr Alain Picard, the former Executive Secretary of the CCT, had died on 21 August 2015. He had served the CCT with dedication and Dr Yuan expressed his condolences to Alain's family.

He said that members of the CCT had participated in the Royal Society event 'Towards implementing the new kelvin' in May 2015 and had submitted a paper on the future *mise en pratique*. The CCT Task Group for Environment (CCT TG-Env) had participated in the BIPM Workshop on Global to Urban Scale Carbon Measurements in June 2015, with Dr Peter Thorne (WMO GCOS Reference Upper-Air Network) giving a presentation on 'Impact of GHGs: Measuring global temperature change'. The CCT TG-Env will participate in a breakout session 'Metrology for Environment in the Arctic' at the Arctic Circle Assembly to be held in Reykjavik, Iceland, on 18 October 2015.

## **14. REPORTS FROM THE BIPM TIME DEPARTMENT, CCTF AND CCL**

The meeting was joined by Dr Fang, Dr Robertsson and Dr Viallon.

## BIPM Time Department

Dr Arias spoke about the achievements and activities of the BIPM Time Department during 2013 to 2015. Achievements included the complete refurbishment of the algorithm for International Atomic Time (TAI). Before the new model was implemented, the drift of the free atomic time scale (EAL) with respect to TAI was  $-1.3 \times 10^{-17}$  per day and this drift was difficult to correct with steering. The quadratic model for clock frequency prediction, which was implemented in August 2011, stopped the drift and no steering corrections have been required since November 2012. The weighting algorithm for TAI has been changed to reflect the increasing role of hydrogen masers compared to caesium clocks. The algorithm has subsequently been adapted and the philosophy has changed so that a good clock is now considered to be a predictable clock rather than a stable clock. Most of the highly-weighted clocks are now hydrogen masers. The results have been published in *Metrologia*: Panfilo G. *et al.*, A new weighting procedure for UTC, *Metrologia*, 2014, **51**, 285.

The introduction of Rapid UTC (UTC<sub>r</sub>) has fulfilled the need for a more ‘real-time’ product. It started as a pilot experiment in January 2012 and was declared an official product in July 2013. The impact of UTC<sub>r</sub> on laboratories that contribute to UTC has been more frequent assessment of UTC(k) steering with a consequent improvement in the stability and accuracy of UTC(k) and enhanced traceability to UTC. Users of UTC(k) have gained access to an improved ‘local’ reference and indirectly, better traceability to the UTC global reference. GNSS times have gained better synchronization to UTC through improved UTC and UTC(k) predictions. Stability of UTC<sub>r</sub> over one month is  $4 \times 10^{-16}$  compared to  $3 \times 10^{-16}$  for UTC.

Time and frequency transfer work started using optical fibre links for validation of ‘classical’ GPS links and GPS link calibration. There are two laboratories in Poland that contribute to UTC and which operate a permanent comparison via a calibrated optical fibre link. It was used to validate the BIPM’s calibrator and to assess if the uncertainty of the comparison could be improved. It was found that a  $\leq 2$  ns uncertainty (uB) is achievable. An improved frequency transfer technique was developed with the CNES for solving GPS ambiguities. By using Precise Point Positioning with integer ambiguity resolution (IPPP) it is possible to compare frequency using GPS signals with a performance of  $1 \times 10^{-16}$  and this has been validated by a comparison to an optical fibre link. The results were published in *Metrologia* (Petit G., Kanj A. *et al.*,  $1 \times 10^{-16}$  frequency transfer by GPS PPP with integer ambiguity resolution, *Metrologia*, 2015, **52**, 301.)

Characterization of delays in time transfer equipment continued and a new calibration scheme in coordination with the RMOs has been implemented, including guidelines for GNSS calibrations. The objective is an improvement in the accuracy of [UTC-UTC(k)] by implementing frequent calibration campaigns for reducing time link uB from 5 ns to  $< 2.5$  ns.

The department has contributed strongly to the discussions on the redefinition of UTC and it will be represented at the World Radiocommunication Conference 2015 (WRC-15), Geneva, Switzerland, which will be held on 2 to 27 November 2015. It is expected that a decision on one of the proposed methods for the redefinition will be adopted by the International Telecommunication Union - Radiocommunication Sector (ITU-R).

The Programme of Work for the Time Department for 2016 to 2019 was approved by the CIPM in March 2015. It is consistent with the CCTF Strategy for 2012 to 2023 and the highlights include: further work on accurate time and frequency transfer techniques with a target level of  $10^{-18}$ ; introduction of new optical clock standards in TAI; revision of time link organization and uncertainty evaluation; and support to the redefinition of the second. During the period 2016 to 2019, the Director of the Time Department and two physicists will retire.

The President thanked Dr Arias and invited questions. Dr Milton asked if the CCTF and the relevant

Working Group are happy with the tendency for TAI to be based increasingly on the use of hydrogen masers. Dr Arias replied that there were some concerns about predictability from laboratories that operate masers due to the fact that they do not drift linearly. Previous predictions were based on linear drift. Hydrogen masers do however have a very good weighting. The next improvements to the algorithm may include a two-step process in the time scale; the first step would use masers to provide the basis of the timescale with their good short-term stability, followed by caesium clocks that are necessary for the long-term (30-day) stability. The laboratories are happy with the new algorithm and the masers provide a very good weight. Mr Énard added that this next step represents a mix of stability and predictability.

### **Consultative Committee for Time and Frequency (CCTF)**

Mr Énard, President of the CCTF, reported on its activities from 2013 to 2015. The committee had held its last meeting on 17 to 18 September 2015 and most of its Working Groups had met around the same time. He commented on the work in the NMIs in the time and frequency area where there have been contributions to TAI from five new fountains over the period. There have also been significant and ongoing developments with optical clocks, with most studies aimed at Yb and Sr lattices and Yb<sup>+</sup> and Sr<sup>+</sup> single ions; Hg<sup>+</sup> and Al<sup>+</sup> currently offer the best accuracy.

The CCTF Working Group on Primary and Secondary Frequency Standards (WGPSFS) recommended five new laser-cooled Cs Primary Frequency Standards (PFS) for acceptance into TAI during 2013 to 2015. Three of these were from NMIs that did not previously report PFS: NPLI (India), NIM (China) and VNIIFTRI (Russia). There are now 17 PFS reporting to TAI, with more than five generally available in any given month. At the present time the reported (fractional) systematic uncertainties in PFS range from  $1.5 \times 10^{-16}$  to  $3.9 \times 10^{-15}$  and a statistical analysis has indicated that the PFSs are within reasonable statistical agreement. There has been a resulting improvement in some realizations of UTC.

The CCL-CCTF Frequency Standards Working Group (WGFS) has worked on recommended frequencies and the ratio of frequencies that will lead to a redefinition of the second. There has been agreement on the software used to process the data and the recommended frequencies and related uncertainties have been evaluated and the values have been updated. The Working Group reported on the CCL-K11 comparison and the 'Roadmap for the redefinition of the second' was discussed. Mr Énard commented that 'Recommendation CCTF-CCL 1 (2015): Updates to the list of standard frequencies' will be presented to the CIPM later to validate the new data and the related uncertainties.

The Time Department's work in the area of TAI has already been described in the previous presentation and this work was endorsed by the CCTF Working Group on TAI (WGTAI). The CCTF Working Group on Two-Way Satellite Time and Frequency Transfer (WGTWSTFT) held three formal meetings during the period. It discussed fountain clock comparisons in 2013 between institutes in Europe and Asia and new developments, including TWSTFT carrier phase and broadband two-way. It also discussed the need to restore time links between Europe and Asia following the failure of a satellite in 2014.

The CCTF Working Group on GNSS Time Transfer (WGGNSS) agreed the guidelines for GNSS calibration proposed by the BIPM Time Department which include procedures to calibrate receivers. In the framework of these guidelines, calibrations will be coordinated by the BIPM and the RMOs. The new standard format CGGTTS V2E was published in *Metrologia* (Defraigne P. and Petit G., CGGTTS-Version 2E: an extended standard for GNSS Time Transfer. *Metrologia*, 2015, **52**, G1).

The CCTF Working Group on Coordination of the Development of Advanced Time and Frequency Transfer Techniques (WGATFT) had discussed the results of the 800 km optical fibre link between the LNE-SYRTE, France, and the PTB, Germany. A study group on fibre links has been set up as this is expected to be one of the most important methods of comparing time and frequency in the future. The CCTF Working Group on the CIPM MRA (WGMRA) has developed a series of guidelines including

rules for participation in the computation of UTC and participation in the key comparison CCTF-K001.UTC.

The CCTF Working Group on Strategic Planning (WGSP) has started work on updating the CCTF Strategy document and at its last meeting discussed the preliminary 'Roadmap to the redefinition of the second'. It has also discussed the structure and Chairs of the CCTF working groups and is considering whether the WGTAI should become a discussion forum rather than a Working Group. Mr Énard presented the proposed 'Roadmap to the redefinition of the second' with a target date of 2025 and the four proposed methods for the proposed redefinition of UTC, which will be presented at the WRC-15.

He commented that UME, Turkey, has applied to progress from being an observer to a member of the CCTF. The GUM, Poland, has applied to become a member and MIRS, Slovenia, has requested observership of the CCTF.

Mr Énard completed his presentation by displaying six CCTF Recommendations for noting by the CIPM and one 'CCTF-CCL 1 (2015): Updates to the list of standard frequencies' for approval by the CIPM.

The President thanked Mr Énard and invited questions. Dr Milton initiated a discussion on membership and observership of the Consultative Committees. He commented that in the case of the CCTF, the Space Research Centre of the Polish Academy of Sciences (SRC), Poland, is already a member. If the CIPM were to approve the GUM's application for membership, there would be two members from Poland. This highlighted the wider issue of allowing more than one institute, whether a NMI or a DI, from the same country to become members of the same CC. If this situation were allowed to continue without check, the membership of the CCs could become unmanageable. It was suggested that membership of CCs should be discussed at the next meeting of the CC Presidents to determine how much harmonization is required. There is a clear list of requirements for membership of the CCs, however it was suggested that if there is a need to review the situation, all current applications for membership and observership should be put on hold until after the next meeting of the CC Presidents, unless there is a CC meeting that will be held before this that requires a decision. Prof. Ullrich noted that the CCU will hold its next meeting in June 2016, so a decision on membership is required. It was considered that a more strategic approach to CC membership is required and there is a good case for evaluation committees within the CCs to assess applications. One approach would be to allow the CCs to make recommendations based on best practice, with the proviso that a considered strategic review will be carried out in the future. Clear guidelines are needed for membership of the CCs to ensure that new CC Presidents follow best practice. The President summed up the discussion by noting that a review of the CC membership criteria and processes will be carried out and the outcome will be reviewed by the CIPM at its next meeting in October 2016. He suggested that all current applications for membership should be postponed until that time (see §16).

Mr Énard presented 'Recommendation CCTF-CCL 1 (2015): Updates to the list of standard frequencies' for adoption by the CIPM. Concerns were expressed by some members of the CIPM that they had only received the Recommendation during the meeting and therefore had not had time to give it due consideration. Mr Énard commented that the CCL had only held its meeting two-weeks before the CIPM meeting and the Recommendation had been drafted as quickly as possible. Dr Milton recalled that the technical experts in both the CCTF and CCL meetings had endorsed the Recommendation. It was agreed that the CIPM could vote to provisionally endorse the Recommendation with approval to be confirmed by correspondence within a three-week period. If no objections are received before this deadline, the Recommendation will stand.

**Decision CIPM/104-43** The CIPM adopted the Recommendation 'Updates to the list of standard frequencies' of the Consultative Committee for Time and Frequency (CCTF) and the Consultative Committee for Length (CCL) as CIPM Recommendation CI-2015, subject to any comments submitted by CIPM members in the three weeks following the meeting.

### Consultative Committee for Length (CCL)

Prof. Inguscio, President of the CCL, commented that the CCL meeting held in September 2015 had been his first and he acknowledged Dr Andrew Lewis, NPL, UK, for his help in preparing for the meeting. He presented the current Working Group and Discussion Group structure of the CCL. He commented that 'Recommendation CCTF-CCL 1 (2015): Updates to the list of standard frequencies', which had been presented by Mr Énard for adoption by the CIPM, had been jointly prepared by the CCL and CCTF through the CCL-CCTF Frequency Standards Working Group (WGFS). He presented a further five CCL Recommendations for noting by the CIPM.

Prof. Inguscio informed the CIPM that the CCL had received two applications for observership: the NMCC, Saudi Arabia; and the CMS, Chinese Taipei. Both institutes had made presentations during the CCL meeting and were recommended as observers. It was recalled that during the CCTF discussions it had been agreed to put on hold all applications for membership and observership of the CCs until after the next meeting of the CC Presidents. Dr Milton added that the application from the NMCC, which had been established by the Saudi Standards, Metrology and Quality Organization (SASO), highlighted another issue for discussion by the CC Presidents. Granting observership status to the NMCC would give encouragement to GULFMET and its members to become more involved in the work of the BIPM. Prof. Inguscio completed his presentation by thanking Dr Robertsson for his support as the Executive Secretary of the CCL.

## 15. REPORTS FROM THE BIPM PHYSICAL METROLOGY DEPARTMENT, CCEM, CCM AND CCPR

### BIPM Physical Metrology Department

Dr Stock commented that the department had been created through the merger of the Mass and Electricity Departments on 2 October 2015. He gave a brief overview of the work in the electricity area from the Work Programme for 2013 to 2015. The department carried out two on-site Josephson voltage comparisons (BIPM.EM-K10.a/b) in 2015, at the DMDM, Serbia, and the NIMT, Thailand. A scientific comparison will be carried out at the NMIJ, Japan, in 2015 which will be the first time that the new ac Josephson standard, which was provided through collaboration with the NIST, will be used. This is in preparation for the use of Josephson voltage standards for future ac comparisons and a secondeé from the KRISS, Republic of Korea, will undertake additional development work on the standard in 2016. Two bilateral Zener voltage comparisons were completed in 2015 at the JV, Norway, and the NSAI, Ireland.

An on-site quantum Hall resistance comparison (BIPM.EM-K12) was carried out at the VSL, the Netherlands, in October 2015. These comparisons require the transportation of a significant amount of equipment to the NMIs concerned and as a result, the potential development of table-top QHR systems based on graphene instead of gallium arsenide (GaAs) is being monitored with interest. Preliminary research has found that graphene-based systems can operate at 5 kelvin and 5 tesla instead of the GaAs conditions of 1.2 kelvin and 10 tesla. Measurements made at the BIPM on a graphene sample from MIKES-VTT/Aalto University, Finland, in 2015 confirmed that both graphene and GaAs realize the same resistance but graphene can work at a lower magnetic field.

Three comparisons of resistance calibrations at 1  $\Omega$  and 10 k $\Omega$  (BIPM.EM-K13.a/b) have been carried out in 2015 at the NSAI, Ireland, the NIMT, Thailand, and the CMI, Czech Republic. Comparisons of

capacitance calibrations at 10 pF and 100 pF (BIPM.EM-K14.a/b) are planned with the NIS, Egypt, and the NMISA, South Africa. The BIPM has been chosen as the pilot laboratory for a CCEM-wide capacitance comparison, for which the comparison scheme was discussed at the CCEM meeting in March 2015. The next step will be the development of the technical protocol. There is significant interest in the comparison because a previous EURAMET comparison gave discrepant results which have not been fully understood. The department has carried out three voltage calibrations, 31 capacitance calibrations and 45 resistance calibrations so far in 2015.

Assembly of the calculable capacitor has been completed and the new frequency stabilized laser source and the interferometer are now operational. The measurement chain that links the calculable capacitor to the QHR is fully operational within a few parts in  $10^8$  and further improvements should reduce both type A and B uncertainties. Preliminary measurement of the von Klitzing constant ( $R_K$ ) to within 1 or 2 parts in  $10^7$  is expected before the end of 2015 and a measurement of  $R_K$  approaching the target relative uncertainty of  $1 \times 10^{-8}$  should be possible in 2016.

Dr Stock commented that activities in the mass area are divided between the present definition of the kilogram and the preparations for the new SI. The extraordinary calibrations with respect to the international prototype of the kilogram (IPK) and the mass determination of the  $^{28}\text{Si}$  spheres, as part of the BIPM's participation in the International Avogadro Coordination (IAC) project, have been completed during 2015. The extraordinary calibrations are described in detail in §9 of the report of Session I. The 'mass drift' found during the extraordinary calibrations against the IPK required amendments to 69 certificates for Pt-Ir standards and 92 certificates for stainless steel standards that had been issued to NMIs between 2003 and 2013. Work is ongoing with the development of the future hierarchy of BIPM prototypes and working standards and a new strategy for the use of BIPM standards has been used during the 2015 campaign. New Pt-Ir prototypes have been fabricated for SASO, Saudi Arabia; INM, Colombia; and PTB, Germany, during 2015.

A pilot study for a comparison of the primary realization of the kilogram is required by the 'Joint CCM and CCU roadmap for the new SI'. The objectives of the pilot study are to: test the uniformity of future kilogram realizations based on different primary experiments (watt balances, XRCD); test the continuity between the present and the future realizations of the kilogram; and validate the dissemination schemes. The BIPM will be the pilot laboratory and the technical protocol was completed in September 2015. The conditions for participation are  $u_r(1 \text{ kg}) < 2 \times 10^{-7}$ ,  $u < 200 \mu\text{g}$ , measurements are scheduled for January to October 2016 and the final report is expected in March 2017.

Assembly of the new version of the watt balance is almost complete. It incorporates an open support structure to allow access for alignment and the definitive magnet is now in place and has been aligned to  $30 \mu\text{rad}$ . The new version includes several new features including a dynamic coil alignment system, a mass exchanger, an improved interferometer and an iodine stabilized laser. A secondee from NIM, China, is expected to work on the watt balance project during January to May 2016.

### **Consultative Committee for Electricity and Magnetism (CCEM)**

Dr Rietveld, President of the CCEM, summarized the outcomes of its last meeting, which had been held in March 2015. He commented that one of the highlights was the work towards the 'New SI' and recalled that it has operated a Working Group to review progress with the watt balance for around 20 years. In 2013, the CCEM realized that PR efforts would be required to disseminate information related to the redefinitions and a Task Group had been set up to carry out this work. This Task Group has been discontinued and these efforts have been transferred into the CCEM Working Group on Proposed Modification to the SI (WGSI). The WGSI will focus on the specifics for electricity because the 'New SI' will result in the introduction of small step changes in the size of the electrical units that are realized

using the Josephson and quantum Hall standards and a decision will be needed on the exact timing for the change. He commented that the next CCEM meeting will include a technical session to discuss the ‘big challenges’ that the electricity and magnetism sector is facing and that the CCEM has agreed to make all of its documents publicly available unless there is a compelling reason not to. CENAM, Mexico, has applied to become a member of the CCEM and SCL, Hong Kong (China), has applied to become an observer, although decisions on both applications have been postponed (see decision CIPM/104-46).

Dr Rietveld returned to the issue of the start date for the ‘New SI’ and commented that the opinion of the CIPM is needed. He commented that progress with the determinations of several fundamental constants has given a good indication of the defined numerical values that will be given in the new system to the Planck constant,  $h$ , and the elementary charge,  $e$ . This is especially relevant to electrical metrology as new numerical values for the von Klitzing and Josephson constants, given by the relations  $R_K = h/e^2$  and  $K_J = 2e/h$ , will replace the existing 1990 ‘conventional’ values,  $R_{K-90}$  and  $K_{J-90}$ . The implementation of the new system will require small step changes in the size of the electrical units that are realized using the Josephson and quantum Hall standards. The most significant impact will be in the area of voltage, where a step change of around  $0.1 \mu\text{V/V}$  is anticipated and the change will affect NMIs and industries that operate in the area: the electricity and magnetism community will be affected uniquely by the redefinitions. Dr Rietveld said that there are three options for the timing of the introduction of the new values: on the day of the CGPM decision; on 1 January 2019; or on the day of the CGPM decision, but with implementation by the electricity and magnetism community on 1 January 2019. He went through the pros and cons of each option and asked the members of the CIPM for their opinions. It was questioned if the step change will require changes to existing certificates and Dr Rietveld confirmed that this will be necessary: before the implementation date, the 1990 numbers should be used and after this date, the new numbers should be used. The industrial impact of  $0.1 \text{ ppm}$  will only affect certain high-level customers in the electricity and magnetism community.

The question of the implementation date for the electricity and magnetism sector lead to a wider discussion on the timing of the implementation of the new definitions of the SI base units in general, following approval by the CGPM at its 26th meeting (2018). Dr Milton commented that the CODATA Task Group on Fundamental Constants had met at the BIPM in September 2015 and had expressed an opinion that the change should be made on the day the decision is taken at the CGPM meeting for two reasons. Firstly, the BIPM has developed a timetable that asks CODATA to carry out its work outside of their normal cycle. The CODATA TG has been asked to bring forward its work to fit in with the deadline of 1 July 2017 for acceptance of experimental results that it will use in the evaluation of the fundamental constants leading to the fixed values for the defining constants of the new SI and they have made significant changes to their agenda. With this in mind, CODATA felt that delaying implementation until six weeks after the resolution is passed would not be satisfactory. Secondly, the CODATA TG had concerns over two sets of data being available at the same time. Dr Milton also commented that if an implementation period is required for the new definitions of the SI base units following approval by the CGPM, a period of six weeks would be insufficient and suggested that a much longer period, such as six months, may be required. There was a further discussion with a consensus that all new definitions should come into force at the time the CGPM makes the resolution. The CIPM will consider the issue and will come to a final decision on the timing at its meeting in 2016.

**Decision CIPM/104-44** The CIPM received a report from the President of the Consultative Committee for Electricity and Magnetism (CCEM) on the timing of the implementation of the new definitions of the SI base units following approval by the CGPM at its 26th meeting (2018). The CIPM’s preferred option is that all new definitions should come into force at the time the CGPM makes a resolution. The CIPM agreed to take a final decision at its next session in 2016.

### **Consultative Committee for Mass and Related Quantities (CCM)**

Dr Richard, President of the CCM, commented that he had given a report on the outcomes of the 15th meeting of the CCM, which had been held in February 2015, at the previous session of the CIPM in March. Four presentations had been made during 2015 as part of the campaign to raise awareness of the revision of the SI. The presentations in Germany, China, the USA and Czech Republic covered the consequences for the kilogram and the status of the joint CCM and CCU roadmap for a redefinition of the kilogram in 2018. He said that NIS, Egypt, has applied to become an observer of the CCM and UME, Turkey, has requested to become a full member. Decisions on both applications have been postponed (see Decision CIPM/104-46). Dr Richard reflected on the current situation regarding the membership of CCs, noting that there is no formal review process for existing members, exclusions are rare and the size of the CCs continues to grow. He completed his presentation by noting that all the work outlined in the roadmap for a redefinition of the kilogram is on schedule.

### **Consultative Committee for Photometry and Radiometry (CCPR)**

Dr Usuda, President of the CCPR, informed the CIPM that he had given an invited talk on ‘CCPR activities and the CIPM MRA’ at the International Commission of Illumination (CIE) meeting in Manchester, UK, in June 2015. He will give an invited talk on ‘CCPR Plans and Initiatives on Energy Metrology’ at the Regional Workshop on Measurement Challenges in Renewable Energy and Climate Science at NIM, China, on 29 October 2015. He commented that a ‘CCPR Workshop on Comparison Analysis’ will be held and two of the CCPR Working Groups will meet at NIM, China, during 26 to 28 October 2015. The CCPR is carrying out a pilot study on the spectral responsivity in the THz range and is preparing a pilot study on the detection efficiency of single photon detectors.

Dr Usuda presented the final version of the ‘*Mise en pratique* for the definition of the candela and associated derived units for photometric and radiometric quantities in the International System of Units (SI)’, which has been agreed with the CIE and has been submitted to the CIPM for approval. It has also been submitted to the CCU for consideration. A more comprehensive document ‘Principles of photometry’, which replaces an older document, is being prepared by a joint CCPR-CIE Working Group. The President thanked Dr Usuda and invited comments. There was a brief discussion on the *mise en pratique* and it was agreed that the CIPM welcomed the document, but formal approval was not required.

**Decision CIPM/104-45** The CIPM welcomed the document “*Mise en pratique* for the definition of the candela and associated derived units for photometric and radiometric quantities in the International System of Units (SI)” presented by the President of the Consultative Committee on Photometry and Radiometry (CCPR).

The President thanked the CC Presidents and Executive Secretaries for their presentations and Dr Arias, Dr Fang, Dr Los Arcos, Dr Picard, Dr Quinn, Dr Robertsson, Dr Stock, Dr Viallon and Dr Wielgosz left the meeting.

## **16. SUMMARY OF THE DECISIONS MADE ON MEMBERSHIP AND OBSERVERSHIP OF THE CONSULTATIVE COMMITTEES**

As discussed in §14, a review of the CC membership criteria and processes will be carried out at a meeting of CC Presidents to be held in June 2016 and the outcome will be reviewed by the CIPM at its next meeting in October 2016. All current applications for membership and observership have been

postponed until that time.

**Decision CIPM/104-46** The CIPM will review the policy for approving and reviewing membership and observership of the Consultative Committees at a meeting of CC Presidents to be held in June 2016. The decisions on observer and member status presented at Session II of the 104th meeting of the CIPM are postponed until after this review.

## 17. REPORT FROM THE CIPM SUB-COMMITTEE ON AWARDS

Prof. Inguscio presented the initial proposals from the CIPM Sub-Committee on Awards. He commented that its purpose is to identify type of awards and propose potential candidates to the CIPM. Candidates will be selected for their outstanding contribution to metrology and to encourage activities in support of the objectives of the CIPM. The Sub-Committee is looking into ways it can recognize significant contributions to the development of metrology. It is important that the award selection process recognizes the originality, commitment and achievements of the contributions carried out by the candidates. It is proposed that the Sub-Committee will assign awards on the basis of established and fair criteria.

He presented the draft Terms of Reference for the Sub-Committee. It will administer the awards process by selecting the candidates that have made an outstanding contribution to metrology. Candidates will be proposed to the CIPM for approval. It will identify different types of awards relative to different contributions to metrology and will organize events at which the awards can be assigned. It will publicize the awards and will periodically review and discuss practices for their assignment.

The awards proposed included: medals, an award for an outstanding application of metrology, an award for excellence in achievements and possible honorary membership or letters of appreciation.

The President thanked Prof. Inguscio and asked about eligibility for the various awards. Prof. Inguscio replied that eligibility would depend on the different categories, which have not yet been defined. When the categories are defined, eligibility criteria will be established. The frequency of the awards was questioned. Two proposals were World Metrology Day or at CGPM meetings. Prof. Inguscio suggested that awards aimed at young metrologists could be made at the Varenna Summer School. It was recalled that there are existing awards for contributions to metrology in France and Germany as well as those operated by the APMP and COOMET. It was suggested that more information about the existing awards in metrology around the world should be collected by the Sub-Committee, so that any awards can be uniquely positioned. Other suggestions from the CIPM members included an award aimed specifically at young metrologists to stimulate interest in the subject and one to recognize lifetime achievements by senior metrologists. It was also suggested that a ‘best paper in *Metrologia*’ award could be considered. The President commented that there should not be too many awards; they should be specific and targeted.

## 18. DEPOSITORY OF THE METRIC PROTOTYPES

The visit to the depository of the metric prototypes at the Pavillon de Breteuil took place at 15:30 on 16 October 2015, in the presence of the President of the CIPM and the Director. No representatives of the Curator of the *Archives nationales* were present because the key that is normally held by the *Archives nationales* was still in the possession of the Director following the extraordinary calibrations with respect to the IPK. (see Appendix 3).

## 19. REPORT FROM THE *AD HOC* WORKING GROUP ON TERMINOLOGY

Dr McLaren presented the findings of the *ad hoc* Working Group on Terminology. He summarized the history of the terminology used to refer to the BIPM and its organs. He referred to the statement on terminology of October 2013 that had been developed jointly by Dr Quinn and the BIPM Legal Advisor, Ms Arlen. The text was as follows:

### *Name of the organization*

*The Metre Convention and its Annexed Regulations created an intergovernmental organization named the BIPM, with its seat at the Pavillon de Breteuil. The organs of the BIPM are: the CGPM, the CIPM and the scientific and administrative organ, referred to in practice as the BIPM. This practice is valid when no legal or institutional issue is at stake.*

The CIPM had ‘welcomed and noted this clarification’ at the time. However, during the CIPM meeting in March 2014, Dr Quinn asked to add an agenda point on BIPM terminology, when he said that his views had begun to differ from the jointly agreed text of October 2013. Subsequently, in June 2014 notes on terminology by Ms Arlen and Dr Quinn were considered by the CIPM bureau, which unanimously recommended to the CIPM that the policy regarding use of the term ‘BIPM’, articulated in the October 2013 joint statement be confirmed. In March 2015, following review by the CIPM of relevant documents, the CIPM decided to create an *ad hoc* Working Group chaired by Dr McLaren to review the issue again and to report back to the CIPM in October 2015.

Dr McLaren said that the name ‘Bureau international des poids et mesures’ and its abbreviation ‘BIPM’ to denote both the installation at Sèvres as well as the international organization is firmly entrenched in practice, in particular within the metrology community. Two external experts in international law (one in Switzerland, the other in Germany) informally consulted by the WG have both indicated that the use of ‘Bureau international des poids et mesures’ and ‘BIPM’ with both of these meanings does not represent a problem.

The WG therefore recommended that the two uses of the name ‘BIPM’ can coexist as appropriate allowing flexibility both in terms of accuracy and in terms of practicality. The Working Group therefore recommended that the CIPM confirm the joint statement of October 2013 from Dr Quinn and Ms Arlen.

The President thanked Dr McLaren and asked for comments. Several opinions were expressed; the consensus view was that the joint statement from October 2013 remains valid. The CIPM therefore agreed that after receiving the report of the *ad hoc* Working Group on Terminology the matter was now closed and the current practice stands. The CIPM encouraged the Director to work with Dr Quinn to update the BIPM website to reflect the essence of the joint statement where appropriate.

**Decision CIPM/104-48** The CIPM received the report of the *ad hoc* Working Group on Terminology, considered the matter to be closed, decided to leave the current practice to stand and encouraged the Director to work with Dr Quinn to update the BIPM website accordingly.

## 20. BIPM WORKSHOPS

Dr Milton commented that the presentations from the BIPM ‘Workshop on Global to Urban Scale Carbon Measurements’, which was held on 30 June to 1 July 2015 are available on the BIPM website.

The BIPM/Italian Physical Society, Metrology Summer School will be held in Varenna, Italy, in June to July 2016. METAS will support some participants to the summer school in the context of the CB&KT programme.

The joint BIPM/World Anti-Doping Agency (WADA) workshop on ‘Standards and Metrology for Anti-Doping Analysis’ will be held on 28 to 29 September 2016. It was noted that the timing of the workshop is appropriate because 2016 is an Olympic year.

The proposed BIPM/Versailles Project on Advanced Materials and Standards (VAMAS) workshop on ‘Challenges in materials metrology’ is planned to be held at the BIPM in May to June 2016.

A ‘quantum metrology’ workshop is planned for 2017.

## 21. OPERATION AND FREQUENCY OF FUTURE CIPM MEETINGS

Dr Milton informed the CIPM about the date of certain meetings in 2016. In particular there will be a meeting of CC Presidents on 13 June 2016, followed by a meeting of the CCU from 14 to 16 June. He suggested that there would be an opportunity to hold meetings of some of the CIPM Sub-Committees and *ad hoc* Working Groups during the same week. There will be a meeting of the CIPM bureau on 17 June. The Working Group on the CIPM MRA review is scheduled to meet on 14 to 15 March 2016.

He added that the next meeting of the CIPM is scheduled for 26 to 28 October 2016, following the meeting of NMI Directors on 24 to 25 October 2016. He said that the CIPM bureau shared the opinion that a single three-day CIPM meeting will be sufficient to capture all of the business without the duplication that occurs when two meetings are held each year. Some members expressed their disquiet over reducing the overall duration of CIPM meetings from four days each year to three. The President suggested that some of the business carried out by the CIPM could be done by correspondence and the processes and procedures followed both before and during CIPM meetings need to be reviewed to improve efficiency.

## 22. ANY OTHER BUSINESS

The President invited Dr Milton to introduce the paper ‘Consequences of CODATA-14 for the communication of the proposed changes to the definitions of the base units of the SI’ so that the CIPM could note some of the points in it. Dr Milton said that the paper included an alternative proposal for the definition of the SI base units to the “fixed”  $h$  and  $e$  approach. He said that the proposal discussed in the paper would have no impact on current experimental work, including the watt balance and the Avogadro experiments or the preparation work in mass and electricity towards the redefinitions. It could help to rectify a possible limitation in using the fixed  $h$  and  $e$  approach to define the base units of the SI, which is the difficulty in articulating the definition of the kilogram. An alternative proposed in the paper would define the kilogram with respect to the atomic mass constant. This would not make any significant change in the uncertainty of the Avogadro or the watt balance methods for realizing the kilogram but the definition of the kilogram would be much easier to understand. The chemistry community would benefit from the use of fixed values for the molar mass constant, the Avogadro constant and the atomic mass unit. The disadvantage would be that it would put a small uncertainty onto the values of  $K_J$  and  $R_K$ . This uncertainty would be 100 times or 1000 times smaller, in the different constants, than the shift in those values when the change is made. Since the metrology community is able to manage this shift they could now be asked if there would be a problem adopting an uncertainty that is 100 or 1000 times smaller, bearing in mind that the mass and chemistry communities would benefit.

The President commented that the CIPM is duty bound to come up with the best options for the changes to the definitions of the base units of the SI and that the paper presents an alternative. It was suggested

that the paper be circulated to stimulate a debate on whether or not to continue with the fixed  $h$  approach<sup>4</sup>.

Dr Usuda said that he is currently the President of both the CCAUV and the CCPR. He noted that he intends to stand down as the President of the CCPR at its next meeting scheduled for September 2016. Since the next meeting of the CIPM is scheduled for October 2016 he asked the CIPM to consider possible candidates to succeed him as President of the CCPR.

### **23. CLOSURE OF THE MEETING**

The President thanked the CIPM members for their contributions and closed Session II of the 104th meeting.

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<sup>4</sup> Following the meeting, the CIPM decided by correspondence to continue with the fixed  $h$  approach.

## Appendix 1

### REPORT OF THE SECRETARY ON THE CIPM BUREAU MEETINGS

(June and October 2015)

The CIPM bureau met twice at the BIPM since the last session, on 18 to 19 June and 11 to 12 October 2015. The agenda of the bureau meetings included the usual administrative and financial matters; the following paragraphs summarize other agenda items.

#### **Preparation for the CIPM MRA Review**

This item included a review of an updated agenda of the NMI Directors meeting that will kick off the CIPM MRA review and of the draft terms of reference and membership of the working group that will be established at that meeting. Prior to the meeting, participants will have received two background documents: an overview to recall the objectives and benefits of the CIPM MRA and a summary of data collected from the KCDB prepared by the JCRB Executive Secretary intended to guide discussion at the meeting. Many more documents received from the NMIs have been posted on the BIPM website.

#### **BIPM Pension Plan**

Mr Énard, the Chair of the Sub-Committee on the BIPM Pension and Provident Fund and Health Insurance (PP&HI), attended the parts of the meetings devoted to this agenda item. The Sub-Committee continues to evaluate the long-term results of various modifications to the current defined benefit pension plan, including increase of the minimum retirement age for full pension benefits, increase in employee contributions and supplementary cash contributions from the BIPM. The Director, accompanied by Mr Énard and Dr Bock, met with the staff on 25 September 2015 to brief them about possible changes to the pension plan.

Transition of the current Sub-Committee to the ongoing Pension Fund Advisory Board (PFAB) will be the subject of a motion at the CIPM meeting in October 2015. The PFAB will continue to operate as a CIPM Sub-Committee but will include one or more external experts on pension plan management as well as an elected member of the BIPM staff. Draft terms of reference for this board have been developed by the PP&HI Sub-Committee.

#### **BIPM Staff**

The Director reported five retirements and recruitments to fill the three resulting vacancies. He also announced his intention to staff three new positions: a communications officer in the International Liaison and Communication Department, a human resources specialist, and a mason for site and building maintenance. It was agreed that the Director would seek approval from the CIPM to extend the contract of Dr Los Arcos until he is 67.

#### **BIPM Capacity Building and Knowledge Transfer Programme**

Dr Wielgosz and Mr Henson reported progress on development of activities within the Capacity Building and Knowledge Transfer Programme.

Dr Wielgosz reported progress on a project to facilitate the development of capabilities for the determination of mycotoxins (toxic fungal metabolites) in food materials. Establishment of this capability is a high priority for a number of developing countries in the AFRIMETS region. Visiting scientists from NMIs seconded to the BIPM will work with BIPM staff to develop value assigned calibration solution samples for five key mycotoxins, in the process acquiring hands-on experience with the procedures needed to assess the purity of such samples. A final element of the project will be the BIPM coordination

of an international comparison of mycotoxin calibration solutions. It was reported at the June bureau meeting that this project was not included in the current BIPM work programme, therefore funding would need to be secured from voluntary funds and in-kind contributions. The bureau encouraged Dr Wielgosz to pursue this initiative, and agreed that it be a proposed project within the BIPM Capacity Building and Knowledge Transfer Programme. Subsequently, it was announced at the October bureau meeting that commitments of 161 k€ and 3 person years have been made by three NMIs. Mr Henson reported that a grant of \$213,000 secured with NIST assistance will enable the BIPM to implement two training activities aimed at countries with developing metrology infrastructure. The first of these, to be launched in 2016 is intended for future RMO TC and WG Chairs; the second, to be launched in 2017, is aimed at countries that are developing their first CMCs. Preference is to be given to AFRIMETS and SIM countries.

### **CCU Membership**

The bureau considered a proposal by Prof. Ullrich to address concerns about the membership of the CCU. At least two NMIs have expressed a desire to be members of the CCU. According to the current rules for CCU membership, only the current seven NMIs can be accommodated. The bureau considers that the current criteria for CCU membership may be unnecessarily restrictive with respect to NMI participation. It was agreed that the CCU President would be asked to consider changes to these criteria. The proposal will be discussed at the CIPM meeting in October.

### **Draft SI Resolution for the 26th CGPM**

The bureau reviewed a recent draft of the resolution on the changes to the definitions of SI units to be presented at the 2018 CGPM. Those members present (Dr Inglis, Dr May and Dr McLaren) expressed concerns about the suitability of this version of the resolution for a wider audience that will include many persons who have not been closely involved in the scientific work and the many discussions at both the CCU and the CIPM that have preceded the formulation of this draft. They recalled that Resolution 1 of the 24th CGPM (2011) invited the CIPM to “continue its work towards improved formulations for the definitions of the SI base units in terms of fundamental constants, having as far as possible a more easily understandable description for users in general, consistent with scientific rigour and clarity”. They felt that whilst the current draft of the resolution fully meets the requirement for scientific rigour, a more easily understandable text is needed for “users in general”. It was agreed that these concerns would be communicated to Prof. Ullrich (who unfortunately was absent from the June bureau meeting because of a conflict with another meeting). Discussions at the October bureau meeting centred on the need to make the resolution as widely accessible as possible.

### **Committee for Election of the CIPM**

Since the 25th CGPM meeting, the Secretary has been in regular contact with the Chair of the Committee for Election of the CIPM (the CEC), Dr Friederike Weritz. He organized an email vote of its members by which the draft procedures for the operation of the CEC were approved in late September. The procedures document defines the formation of a CEC by election during each CGPM meeting, replacement of members because of vacancies arising between CGPM meetings, and the role of the CEC, in collaboration with the CIPM, in developing a recommended slate of candidates for election to the CIPM.

### **Meeting with RMO Chairs/Presidents**

The bureau met with the Chairs/Presidents of AFRIMETS, APMP, EURAMET and SIM for an informal exchange of information and ideas about how the BIPM and CIPM could work most efficiently and effectively with the RMOs. The President will report on this meeting later in the agenda.

## Appendix 2

## RECOMMENDATIONS ADOPTED BY THE CIPM

## RECOMMENDATION 2 (CI-2015)

## Updates to the list of standard frequencies

The International Committee for Weights and Measures (CIPM),

## considering

- a common list of “Recommended values of standard frequencies for applications including the practical realization of the metre and secondary representations of the second” has been established,
- the CCL-CCTF Frequency Standards Working Group (WGFS) has reviewed several candidates for updating the list,

## recommends

that the following transition frequencies shall be updated in the list of recommended values of standard frequencies:

- the unperturbed optical transition  $6s^2\ ^1S_0 - 6s6p\ ^3P_0$  of the  $^{199}\text{Hg}$  neutral atom with a frequency of  $f_{199\text{Hg}} = 1\ 128\ 575\ 290\ 808\ 154.8$  Hz and an estimated relative standard uncertainty of  $6 \times 10^{-16}$ ;
- the unperturbed optical transition  $6s\ ^2S_{1/2} - 4f\ ^{13}6s^2\ ^2F_{7/2}$  of the  $^{171}\text{Yb}^+$  ion with a frequency of  $f_{171\text{Yb}^+}$  (octupole) =  $642\ 121\ 496\ 772\ 645.0$  Hz and an estimated relative standard uncertainty of  $6 \times 10^{-16}$  (this radiation is already endorsed by the CIPM as a secondary representation of the second);
- the unperturbed optical transition  $6s\ ^2S_{1/2} (F = 0, m_F = 0) - 5d\ ^2D_{3/2} (F = 2, m_F = 0)$  of the  $^{171}\text{Yb}^+$  ion with a frequency of  $f_{171\text{Yb}^+}$  (quadrupole) =  $688\ 358\ 979\ 309\ 308.3$  Hz and an estimated relative standard uncertainty of  $6 \times 10^{-16}$  (this radiation is already endorsed by the CIPM as a secondary representation of the second);
- the unperturbed optical transition  $5s\ ^2S_{1/2} - 4d\ ^2D_{5/2}$  of the  $^{88}\text{Sr}^+$  ion with a frequency of  $f_{88\text{Sr}^+} = 444\ 779\ 044\ 095\ 486.6$  Hz and an estimated relative standard uncertainty of  $1.6 \times 10^{-15}$  (this radiation is already endorsed by the CIPM as a secondary representation of the second);
- the unperturbed optical transition  $4s\ ^2S_{1/2} - 3d\ ^2D_{5/2}$  of the  $^{40}\text{Ca}^+$  ion with a frequency of  $f_{40\text{Ca}^+} = 411\ 042\ 129\ 776\ 398.4$  Hz and an estimated relative standard uncertainty of  $1.2 \times 10^{-14}$ ;
- the unperturbed optical transition  $1S - 2S$  of the  $^1\text{H}$  neutral atom with a frequency of  $f_{1\text{H}} = 1\ 233\ 030\ 706\ 593\ 514$  Hz and an estimated relative standard uncertainty of  $9 \times 10^{-15}$ .

Note: This frequency corresponds to half of the energy difference between the 1S and 2S states;

- the unperturbed optical transition  $5s^2\ ^1S_0 - 5s5p\ ^3P_0$  of the  $^{87}\text{Sr}$  neutral atom with a frequency of  $f_{87\text{Sr}} = 429\ 228\ 004\ 229\ 873.2$  Hz and an estimated relative standard uncertainty of  $5 \times 10^{-16}$  (this radiation is already endorsed by the CIPM as a secondary representation of the second);
- the unperturbed optical transition  $6s^2\ ^1S_0 - 6s6p\ ^3P_0$  of the  $^{171}\text{Yb}$  neutral atom with a frequency of  $f_{171\text{Yb}} = 518\ 295\ 836\ 590\ 864.0$  Hz and an estimated relative standard uncertainty of  $2 \times 10^{-15}$  (this radiation is already endorsed by the CIPM as a secondary representation of the second);

- the unperturbed ground-state hyperfine transition of  $^{87}\text{Rb}$  with a frequency of  $f_{87\text{Rb}} = 6\,834\,682\,610.904\,310$  Hz and an estimated relative standard uncertainty of  $7 \times 10^{-16}$  (this radiation is already endorsed by the CIPM as a secondary representation of the second).

and also **recommends**

that the following transition frequencies shall be included in the list of recommended values of standard frequencies:

- Absorbing molecule  $^{127}\text{I}_2$ , saturated absorption  $a_1$  component, R(36) 32-0 transition.

$$\text{The values } f_{a_1} = 564\,074\,632.42 \text{ MHz}$$

$$\lambda_{a_1} = 531\,476\,582.65 \text{ fm}$$

with an estimated relative standard uncertainty of  $1 \times 10^{-10}$  apply to the radiation of a frequency-doubled diode DFB laser, stabilized with an iodine cell external to the laser.

- Absorbing atom  $^{87}\text{Rb}$   $5S_{1/2} - 5P_{3/2}$  crossover between the d and f hyperfine components of the saturated absorption at 780 nm (D2 transition)

$$\text{The values } f_{d/f \text{ crossover}} = 384\,227\,981.9 \text{ MHz}$$

$$\lambda_{d/f \text{ crossover}} = 780\,246\,291.6 \text{ fm}$$

with an estimated relative standard uncertainty of  $5 \times 10^{-10}$  apply to the radiation of a tunable External Cavity Diode Laser, stabilized to the d/f crossover in a rubidium cell external to the laser.

Note: The value of the standard uncertainty is assumed to correspond to a confidence level of 68 %. However, given the limited availability of data there is a possibility that in hindsight this might not prove to be exact.

## Appendix 3

## Visite du dépôt des prototypes métriques

## PROCÈS-VERBAL

Le 16 octobre 2015 à 15 heures 30 en présence du Président du Comité international des poids et mesures et du directeur du Bureau international des poids et mesures, il a été procédé à la visite du dépôt des prototypes métriques internationaux du Pavillon de Breteuil.

On avait réuni les trois clefs qui ouvrent le dépôt : celle qui est confiée au directeur du Bureau international, celle qui est habituellement déposée aux Archives nationales et actuellement confiée au directeur du Bureau international des poids et mesures pour la campagne extraordinaire d'étalonnage avec le prototype international du kilogramme, et celle enfin dont le Président du Comité international a la garde.

Les deux portes de fer du caveau ayant été ouvertes ainsi que le coffre-fort, on a constaté dans ce dernier la présence des prototypes et de leurs témoins.

On a relevé les indications suivantes sur les instruments de mesure placés dans le coffre-fort :

température actuelle	:	22 °C
température maximale	:	23 °C
température minimale	:	21 °C
état hygrométrique	:	55 %

On a alors refermé le coffre-fort ainsi que les portes du caveau.

Le Directeur  
du BIPM



M.J.T. MILTON

Le Président  
du CIPM



B.D. INGLIS