International Committee for Weights and Measures

Proceedings of the 106th meeting

(16-17 and 20 October 2017)

Executive Summary

The 106th meeting of the CIPM (16-17 and 20 October 2017)

The revised SI

The CIPM welcomed recommendations regarding the redefinition of the SI from its CCs. The CIPM noted that the agreed conditions for the redefinition have been met and decided to submit Draft Resolution A to the 26th meeting of the CGPM and to undertake all other necessary steps to proceed with the planned redefinition of the kilogram, ampere, kelvin and mole.

The CIPM accepted the revised Draft Resolution A with minor modifications.

The CIPM authorized the CIPM President to convey its support for the publication of the final numerical values for the defining constants to the Task Group for Fundamental Constants convened by CODATA.

The CIPM requested the CCM to provide a formally approved note on the dissemination process after the redefinition of the kilogram, addressing in particular the definition of the consensus value, as well as an updated *mise en pratique*.

Member States in arrears

The CIPM decided to draft a resolution for submission to the 26th meeting of the CGPM regarding the process for the exclusion of Member States in arrears.

Modifications to the BIPM Pension Fund

The CIPM modified the Regulations of the Pension Fund relating to the PFAB to add one elected representative of pensioners and deferred pensioners of the BIPM and to increase the number of serving staff elected by the BIPM staff to the PFAB from one to three.

The CIPM decided that the unit used to calculate pensions shall henceforth be the Pension Point and that the CIPM may modify it if the need to ensure long-term financial sustainability arises.

Liaison organizations

The CIPM decided that the status of liaison within the context of the CCs will be decided upon in each case by the CIPM according to defined criteria. Organizations that are not offered liaison status will be known as “organizations in cooperation”.

Long-term financial plan for the BIPM (2020-2023)

The Director presented a long-term financial plan for the BIPM covering the period 2020 to 2023.

The CIPM decided to revise the level of reserves shown in the *Rapport Financier* to 50 % of the annual dotation to act as a buffer against late or defaulting payments.

Micro-CEEMS

The CIPM adopted criteria that will allow States with a percentage lower than 0.02 % on the “Scale of assessments for the apportionment of the expenses of the United Nations” to become engaged in the activities of the BIPM. Such States will be known as micro-CEEMS.

MEMBERS OF THE INTERNATIONAL COMMITTEE FOR WEIGHTS AND MEASURES

As of 16 October 2017

President

B. Inglis, Lindfield, Australia.

Secretary

J.W. McLaren, Ottawa, Canada.

Members

F. Bulygin, Moscow, Russian Federation.

M. Buzoianu, Bucharest, Romania.

I. Castelazo, Querétaro, Mexico.

Y. Duan, Beijing, China.

L. Érard, Paris, France.

D.-I. Kang, Daejeon, Republic of Korea.

H. Laiz, Buenos Aires, Argentina.

T. Liew, Singapore.

W. Louw, Pretoria, South Africa.

W.E. May, Gaithersburg, United States of America. *CIPM Vice-President*.

M.L. Rastello, Turin, Italy.

P. Richard, Bern-Wabern, Switzerland.

G. Rietveld, Delft, the Netherlands.

M. Sené, Teddington, United Kingdom.

J. Ullrich, Braunschweig, Germany. *CIPM Vice-President*.

T. Usuda, Tsukuba, Japan.

Honorary members

W.R. Blevin, Glenhaven, Australia.

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

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 the 105th meeting (26–28 October 2016) and list of decisions
3. Report on the work of the CIPM bureau by the CIPM Secretary
4. Update on the activities of the BIPM by the Director
5. BIPM finance
6. Update on Member States and Associate States/Economies
7. Exclusion of Member States in arrears
8. The BIPM Pension and Provident Fund
9. Report from the *ad hoc* Working Group on Conditions of Employment
10. Reports from the CCU and CCM on progress towards the possible redefinition of the SI
11. Update on the CIPM Task Group for Promotion of the SI
12. Reports from the BIPM Chemistry Department, JCTLM and CCQM
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. Revision of the rules for participation in CCs
17. Summary of applications for Membership and Observership of the CCs
18. The engagement of states with very-low GDP and with emerging metrology systems (micro-CEEMS) in the activities of the BIPM
19. Discussion and approval of the BIPM Strategic Plan (2018)
20. Preview of the long-term financial plan for the BIPM
21. Agenda and timetable for the 26th meeting of the CGPM (2018)
22. Preparations for the election of the CEC and the CIPM at the 26th meeting of the CGPM
23. Depository of the metric prototypes
24. Reports from meetings and the CIPM Prize Sub-Committee
25. BIPM Liaison and Coordination report
26. Dates of meetings for 2018 and 2019
27. Any other business

1. OPENING OF THE SESSION; QUORUM; AGENDA

The International Committee for Weights and Measures (CIPM) held its 106th meeting on Monday 16 to Tuesday 17 and Friday 20 October 2017 at the International Bureau of Weights and Measures (BIPM).

Present: F. Bulygin, M. Buzoianu, I. Castelazo, Y. Duan, L. Érard, B. Inglis, D.-I. Kang, H. Laiz, T. Liew, W. Louw, W.E. May, J.W. McLaren, M.J.T. Milton (Director of the BIPM), M.L. Rastello, P. Richard, G. Rietveld, M. Sené, 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 and Drafting Officer) and R. Sitton (Publications Officer).

The following were in attendance for parts of the meeting: S. Arlen (Head of Legal Services), 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), R. Guliyeva (International Liaison Assistant), S. Judge (Director of the Ionizing Radiation Department and Executive Secretary of the CCRI), E. de Mirandés (Executive Secretary of the CCU), G. Panfilo (Executive Secretary of the CCAUV), S. Picard (KCDB Coordinator and Executive Secretary of the 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), A. Wallard (Emeritus Director) 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. He said that Dr Liew will arrive later in the morning and that Dr Castelazo, Dr Kang and Dr Ullrich will not be present for the session on Friday 20 October. He welcomed the three new members of the CIPM: Dr Laiz, Dr Rastello and Dr Sené. With 17 members present the quorum was satisfied according to Article 12 of the Regulations annexed to the Metre Convention.

He noted that item 9 on the agenda "Report from the *ad hoc* Working Group on Conditions of Employment" had been withdrawn because it had not met since the last meeting of the CIPM. Item 10 "Report from the CCU on progress towards the possible redefinition of the SI" will include a report from the CCM. There were no additional comments on the agenda, which was approved.

The President reported the deaths of three former CIPM members: Dr John Vernon Dunworth (1917-2017); Dr Bernard Guinot (1925-2017); and Dr Ernest Ambler (1923-2017). Dr Dunworth was a Vice-President of the CIPM from 1968 to 1975 and CIPM President from 1975 to 1985. He was one of the founders in 1974 of the Western European Metrology Club, the precursor of EURAMET, having recognized the growing need for collaboration in Europe between what at the time were known as the national standards laboratories. Dr Guinot was a member of the CIPM from 1978 to 1984 and President of the *Comité Consultatif pour la Définition de la Seconde* (now the CCTF). In 1985, he was responsible for moving the BIH activity on TAI to the BIPM. He thus became the first "Head of the BIPM Time Section" and started the BIPM''s work on time scales. He retired in 1990. Dr Ambler was the eighth Director of NIST (1978-1989) and a CIPM member from 1972 to 1989 after which he became an Honorary Member. He was also President of the Consultative Committee for Standards of Ionizing Radiations (CCEMRI, now the CCRI) from 1974 to 1985 and President of the Consultative Committee for Electricity (CCE now the CCEM) from 1985 to 1989. The committee observed a minute's silence as a mark of respect.

2. CONFIRMATION OF THE MINUTES OF THE 105TH MEETING (26-28 OCTOBER 2016) AND LIST OF DECISIONS

The minutes of the 105th meeting (2016) had been approved by correspondence and were accepted as a true record.

Decision CIPM/106-01 The CIPM accepted the minutes of the 105th meeting of the CIPM as a true record.

There were no comments on the decisions from the 105th meeting (2016) and the President commented that all the actions associated with the decisions had been completed.

3. REPORT ON THE WORK OF THE CIPM BUREAU BY THE CIPM SECRETARY

Dr McLaren, Secretary of the CIPM, gave his report (see Appendix 1). The verbal report covered the bureau meeting held on 13-15 October 2017. He commented that written reports of the meetings held on 9-10 March and 12 and 14 June 2017 were available on the CIPM webpage. These reports also covered the Secretary's attendance at the annual Management Review meetings for the BIPM Quality Management System and the Health and Safety System, the annual BIPM/ILAC and BIPM/OIML bilateral meetings and the annual BIPM/ILAC/OIML/ISO quadrilateral meeting, all of which were held in March 2017.

Dr McLaren's report mentioned a draft decision that had been reviewed by the bureau relating to a proposal to harmonize the policy for engagement of international organizations as "liaison" members of CCs. He was asked to expand on this but noted that more detail will be given in §15 "Revision of the rules for participation in CCs".

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

Dr Milton reported on a year during which a lot has been achieved at the BIPM.

The major highlight since the last meeting of the CIPM has been the completion of the BIPM's first activities in the new area of capacity building. These include a workshop for 18 participants from ten Member States and five Associates entitled "Leaders of Tomorrow" which was sponsored by the NIST. A second workshop entitled "Sound beginning in the CIPM MRA" will be held in November 2017.

The BIPM's capacity-building work also includes technical activities under the "Metrology for Safe Food and Feed" project coordinated by the BIPM Chemistry Department, which supports NMIs in strengthening their national infrastructure for mycotoxin analysis and standards.

The Capacity Building activities are developed and implemented by the International Liaison and Communication Department led by Mr Andy Henson. In response to the increasing demand for their work and for information from Member States and Associates States, the Director has increased the staff supporting Mr Henson in the department, by recruiting Ms Rahima Guliyeva who has joined as an International Liaison Officer, bringing experience from the WTO, and Ms Justine Evans who has joined as a Communications Officer, bringing experience from CEN in Brussels. Together with Mr Chingis Kuanbayev, who joined the BIPM before the last CIPM meeting in 2016, they now form a team that greatly increase the effectiveness of its Liaison activities.

This department now has staff of seven nationalities who speak nine languages. They have: facilitated a reduction in outstanding dues from Member States and Associates; enabled the start of new activities, such as the collaboration with International Organizations coordinated by the OECD; and started to further improve our communications ahead of the 26th CGPM (2018).

This has also been a year in which the BIPM has established two important new collaborations: Firstly with the DOSEO facility at the *Commission pour energie atomique* (the CEA) in Saclay, which provides the BIPM with access to a linear accelerator that will enable it to conduct key comparisons for NMIs. Secondly with the *Centre Internationale des etudes pedagogique* (the CIEP) in Sèvres, which can provide meeting rooms for the BIPM's largest meetings, such as the CCQM, as well as accommodation for participants at BIPM meetings.

Dr Milton said that since becoming Director, it has been a priority to increase the involvement of visiting scientists in the work of the BIPM. This has required much more work within the BIPM human resources team; in November 2016, we were joined by a new Head of HR – Mr Philippe Imbert. He has worked with his HR Assistant to increase the rate of recruitment to match the needs of our programme. Twelve new staff joined during 2017 together with two joining from appointments offered at the end of 2016. This follows five retirements, four leaving and sadly one deceased. Of particular importance amongst recruitments have been two new Department Directors: Dr Steven Judge, who has joined to replace Mr José María Los Arcos as the Director of the Ionizing Radiation Department and brings considerable experience both from the world of NMIs and also from industry; and Dr Patrizia Tavella, who has joined to replace Dr Felicitas Arias as the Director of the Time Department who brings much experience from an NMI as well as having worked on collaborative projects to disseminate time scales.

In addition the following staff joined the BIPM in 2017: Mr Bastian Avenel (Head Gardener), Ms Evelyne Van (Assistant Principal Accountant), Ms Johanna Goncalves (Time) and Dr Gustavo Martos (Chemistry). The recruitment of a new Quality, Health and Safety Manager, a replacement for Dr Guy Ratel (Principal Research Physicist), a new technician in the Physical Metrology Department and an additional secretary to support the preparations for the 26th CGPM are all under way.

The Director said that at the end of 2017 the BIPM will be exactly on the headcount of 74 approved at the 25th CGPM, but noted the significant move towards appointing staff on fixed-term contracts (CDD); from just three when he started in 2013 to seven (or eight) by the end of 2017. By the end of 2018, 25 staff will have been recruited (out of 74) since Dr Milton took over as Director.

As mentioned, there has been a significant increase in the number of visiting scientists from the NMIs working at the BIPM. This year, the BIPM has reached a record of 12 person years of effort contributing to its work by 30 different visitors. Increasing participation of this sort has been a priority for the Director and is now at a level that is three times the level it was when he started at the BIPM 5 years ago. He commented that the BIPM is now at the maximum for an organization arranged in the way that it is at present.

The BIPM continues to be very active in promoting the role of metrology internationally. In September 2017 it hosted a workshop on the Quantum Revolution in Metrology – the workshop was a step forward in the way the BIPM organizes such meetings – in that it involved 137 participants from 27 countries presenting 23 oral papers and 56 posters.

Also in September, a workshop was held entitled "The fundamental constants of physics: what are they and what is their role in redefining the SI?" The Director commented that it included some of the most interesting and stimulating talks that he had heard since being at the BIPM. The talks are available on the webpage and he recommended them.

Another area in which the BIPM has been very busy has been with the implementation of the pension reforms agreed at the last CIPM meeting. These will be discussed later in the agenda, and it is hoped that this will mark the point after which we can indicate that the measures that we committed to at the 25th CGPM have been implemented.

This short report has focused on operational issues; the CIPM will hear on 17 October reports from the Directors of the departments, who will summarize their progress in the laboratories.

The agendas for meetings of the CIPM have been very full at recent meetings. There are some very significant initiatives under way, not least the steps towards re-definition and the planning for the CGPM in 2018, but also the review of the CIPM MRA and the adoption of a more strategic approach to the BIPM work programme, which has taken the BIPM into capacity building and further liaison activities. These are all very significant steps in the development of the role of the BIPM.

The Director commented that it will not be possible to show the CIPM the renovated laboratories in the Observatoire as there is insufficient time in the agenda. He recalled that, at the session in October 2016, it was generally agreed that more time should be made available for the reports from the BIPM departments, but this has not been possible. The visit to the caveau on Friday will perforce be a very short one.

In addition to the activities already described, 2017 was an extremely busy year for the Director and the BIPM because it hosted a significant number of meetings. There were eight meetings of the consultative committees (when five or six are generally expected). The figures show that the BIPM has had more than 4000 visitor days in 2017, which is nearly 50 % higher than during 2016. This represents a 50 % increase in the number of participants since 2010, with just a 4 % increase in the budget.

This increase is justified because the BIPM will be holding the 26th meeting of the CGPM in 2018. With the plans for the expected re-definition under way; there has never been a more important time to have a BIPM that carries out coordination, liaison and technical roles effectively for the benefit of the Member States.

The President thanked the Director and added that outside of the full agenda mentioned by the Director, the CIPM bureau will meet with the RMO chairs on 17 October and a delegation from Iran on 18 October. Plans for the 26th CGPM will be discussed in item 20 “Agenda and timetable for the 26th meeting of the CGPM (2018)”.

5. BIPM FINANCE

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

Dr Sené gave a brief summary of the 2016 accounts. He thanked Ms Etter (who leads the BIPM Finance Section) and the external accountant from Extenso for their hard work in preparing the accounts in record time. The accounts were audited and signed off on 31 May 2017 without qualification, but with a note on the BIPM Pension and Provident Fund. The CIPM Sub-Committee on Finance had met on 12 June 2017 where it reviewed the financial statements, discussed long-term financial planning, and received an update on the Pension and Provident Fund.

The main points of the financial statements were that income was in line with forecast, and operating expenditure showed a continued reduction (6 % from 2013 to 2016). This reduction in operating expenditure will cover an anticipated increase to cover fees for access to the DOSEO platform at the Saclay facility, which began in 2017. Capital expenditure was limited to 1601 k€ in anticipation of increased expenditure for software and website renewals from 2017 to 2019.

Dr Sené commented that "corrected" EBITDA (earnings before interest, tax, depreciation and amortization, excluding healthcare provision and capitalization of staff costs) is a good measure of the underlying performance and financial management of the BIPM. This figure continued to improve and the corrected EBITDA was 3.2 M€ in 2016, reflecting the good management of the operation and finances of the BIPM. The CIPM Sub-Committee on Finance commended the Director and the BIPM Finance Section on the prudent financial controls against the background of there being no annual increase in the dotation. The members of the Sub-Committee unanimously agreed that the financial statements should be recommended for approval by the CIPM and that the Director should be granted quietus for the audited financial statements of the BIPM and of the BIPM Pension Fund for 2016.

Dr Sené recalled that the CIPM Sub-Committee on Finance had discussed the level of the BIPM reserves. The present policy is that they are 35 % of the dotation. The Sub-Committee recommended that this should be increased, possibly to 50 %, to reflect the uncertain global political situation. This will be discussed further during item 20 "Preview of the long-term financial plan for the BIPM".

The President thanked Dr Sené for his report and invited questions. It was asked if any comparisons are made between the BIPM's financial performance and those of other international organizations. The Director answered that the balance between laboratory and coordination activities at the BIPM is unique. Comparisons with organizations such as the European Space Agency (ESA) and the *Conseil européen pour la recherche nucléaire* (CERN) are not insightful because of their much higher capital costs. Whether or not the EBTIDA will continue to increase was questioned. The Director remarked that a downturn is expected as inflation will start to affect operational costs and when this is combined with the flat dotation, a plateau is anticipated, followed by a sharp downturn. This will be discussed further in item 20 "Preview of the long-term financial plan for the BIPM". Dr Sené added that the underlying good performance had been contributing to the increase in cash and cash equivalent ahead of the expected downturn.

Quietus for the 2016 Financial Report

The Director requested quietus for the audited financial statements of the BIPM and of the BIPM Pension Fund for 2016. The CIPM Sub-Committee on Finance had unanimously agreed at its meeting on 12 June 2017 that the accounts should be recommended for approval by the CIPM and that the Director be granted quietus. The approval of the statements had been carried out by correspondence and final unanimous support had been received in July 2017.

Decision CIPM/106-02 The CIPM confirmed its approval of the audited financial statements of the BIPM and of the BIPM Pension and Provident Fund which it had approved by correspondence in July 2017. The CIPM gave the BIPM Director quietus for the 2016 exercise.

Approval of the budget for 2017 and 2018

The Director said that the budget for 2017 and 2018 required approval by the CIPM. He added that the budget outturn for 2016 (*Rapport Financier 2016*) shows areas where savings had been made against the budget. He highlighted the cost of meetings in 2016, where careful control has been demonstrated. Although there has been a significant increase in the number of participant days to a record of more than 4000 in 2017, the cost of meetings has only risen by 4 % since 2009.

He presented the budget proposal for 2018, as well as 2019 for information, and recalled that a number of budgetary decisions had been made by the CIPM in previous years, including the agreement: to establish a new budget line for contract suppliers; to maintain pension contributions at 2.4 M€ (in excess of the 46 % already committed to); and to make additional pension contributions of 400 k€ in 2018 and 150 k€ per year

from 2019. The budget includes a projected reduction of operating expenditure of 60 k€ in 2018 and 100 k€ in 2019 to reflect the trend of recent years. The budget for both years is expected to be close to being balanced. He gave a detailed breakdown of the budget for operating expenses, showing what was spent in 2016, the projected spend for 2017 and the proposed budgets for 2018 and 2019. A brief explanation was given as to how the value of the *point*[1] has evolved over recent years. The CIPM had previously agreed to cap the *point* at 1 % (See Decision CIPM/104-29) and in 2018 the *point* will be set at 0.8 %.

The Director invited questions. He was asked to elaborate on the projected increase in contributions from Member States in 2018 and 2019. The Director commented that this will be covered more fully later in the agenda under the section on long-term financial planning. Briefly, a certain percentage of Associates that reach the top of the escalator mechanism may become Member States; therefore the extra income generated would be offset by the loss of the income from the Associate. The largest states that are not Members or Associates that might conceivably become Member States directly are Algeria, Libya, Morocco and Nigeria.

The President queried the situation with EDF (the BIPM's electricity supplier) regarding the overcharging for electricity. The Director said that this had started in the first quarter of 2012, and was due to an ageing electricity meter over-reading by about 40 %. He said that EDF has admitted that it made a mistake and has settled out of court, agreeing to reimburse the BIPM around 250 k€. The BIPM is confident that the 250 k€ has been repaid through credits and via a repayment; however it has been difficult to determine the baseline electricity cost accurately.

Decision CIPM/106-03 The CIPM approved the budget proposed by the Director for 2018 (document CIPM/2016 – 05.3).

6. UPDATE ON MEMBER STATES AND ASSOCIATE STATES/ECONOMIES

The meeting was joined by Ms Arlen, Ms Guliyeva and Mr Henson for §6 and 7.

Mr Henson began by recalling that the misunderstanding between Lithuania and the French Ministry of Foreign Affairs regarding its date of accession to the Metre Convention is still unresolved. This has been reported to the CIPM at previous meetings. The BIPM has pressed both the French Ministry of Foreign Affairs and the Lithuanian authorities to clarify the situation. Mr Henson said that, as a result of this experience, the BIPM has now, in consultation with the French Ministry of Foreign Affairs, changed its advice to applicant states indicating that a copy of the instrument of accession should be attached when a state notifies the French Ministry of Foreign Affairs of its decision to accede.

Mr Henson then recalled the situation with the Islamic Republic of Iran with regard to its arrears (See also §27 of the report of Session II of the 103rd meeting of the CIPM and §6 of the report of the 105th meeting of the CIPM). He explained that Iran had become a Member State in 1975, paid its contribution for 1975 together with the entrance fee and a small part of the contribution for 1976. It then fell into arrears. Subsequently, the Institute of Standards and Industrial Research of Iran, under the Ministry of Industry and Mines, wrote a letter to the BIPM in March 1979 advising that '*Iran has to withdraw its membership*' but also "*suggest[s] that at present [Iran's] membership be suspended. If and when the Islamic Republic of Iran considers to join this organization we shall let you know*". The request was not acted upon by the BIPM. Neither was Iran excluded after six years of arrears as required by Article 6 of the Regulations annexed to the Metre Convention.

[1] The point is an internal conversion factor that is used in calculations to correct salaries, allowances and pensions for the cost of living under the present rules. It is based on consumer price index, extracted from the "Annual adjustment of remuneration of the personnel of the coordinated organisations".

Consequently, Iran's contributions were redistributed among the other Member States up to and including 2011.

Following Resolution 6 of the 24th CGPM (2011), the CIPM signed a rescheduling agreement with Iran in 2012, by which Iran agreed to pay its annual contributions and the outstanding debt over a period of seven years. Embodied within the 2012 rescheduling agreement was the recognition that Iran wished to challenge the total amount of its arrears at the 25th meeting of the CGPM in 2014.

In 2014, Iran submitted a letter to the BIPM outlining a case that it wished to raise at the 25th CGPM. However, the letter only arrived a few days before the meeting and was deemed to be too late for Member States to consider ahead of the CGPM meeting. Consequently the CIPM signed an amendment to the Rescheduling Agreement with Iran on 14 November 2014. This amendment required Iran to continue paying its annual contribution whilst exempting it from paying off any more of its arrears pending consideration of its case at the 26th meeting of the CGPM (2018).

Mr Henson reported that at the time when the debt repayments were frozen in 2014, Iran had repaid approximately 417 k€ of the total arrears of 1 446 k€. Iran has made timely and consistent payments of its annual contribution since 2012. At a meeting held at the BIPM on 20 July 2017 a delegation from Iran confirmed that it was still pressing for reconsideration of the total debt and that it intends to take its case to the 26th CGPM (2018). It followed this up by submitting a draft dossier to the BIPM in September 2017.

The Director gave a brief summary of the arguments presented at the July meeting and in the 2017 dossier. He reiterated that Iran argues against paying the full amount listed as arrears, claiming that it had stated its intent to withdraw in the letters sent to the BIPM in 1979, and secondly, that even if this had not been done, then it should have been excluded after six years of arrears under Article 6 of the Regulations annexed to the Metre Convention. Iran asserts that it is unable to pay the disputed arrears because it cannot legally justify the repayment, or put a case to the Iranian parliament, considering that it did not receive any services or benefits from the BIPM for a period of over 30 years. He said that the dossier also includes examples of how similar situations concerning Iran's membership of other international organizations have been dealt with during this period. The Director also drew the attention of the CIPM to a letter from the French Ministry of Foreign Affairs dated 23 September 1999, concerning the possible exclusion of both Iran and the Dominican Republic, which stated:

'La Convention créant le BIPM prévoit en effet qu'après six années d'arriérés l'État déficitaire est exclu de la Convention. Il appartient donc au BIPM de notifier officiellement au Ministère des Affaires Étrangères de la décision du Comité International des Poids et Mesures d'exclure les deux États en cause. Nous en prendrions note comme État dépositaire de la Convention et en informerions ensuite les autres États Membres.'

In English: 'The Convention creating the BIPM provides that, after six year of arrears, the defaulting State is excluded from the Convention. It is therefore the responsibility of the BIPM to officially notify the Ministry for Foreign Affairs of the decision of the CIPM to exclude the two States concerned. As host nation of the Convention, we would take note of this decision and then inform the other Member States.'

The issue had been discussed by the CIPM bureau at its meetings in 1998, 1999 and 2000, but no action was taken.

Mr Henson recalled that whilst the letters received from Iran in 1979 were not procedurally correct, there is no evidence in the BIPM records that any clarification was sought.

Mr Henson then updated the CIPM on the situation with Venezuela, which has not paid its contributions since, and including, 2012. Regular notifications have been sent to its Embassy in Paris and all attempts to establish

contact have failed. A *Note Verbale* had been sent to the Embassy in April 2017 informing Venezuela that, unless the arrears are paid, the 26th CGPM (2018) will be asked to take a decision on its exclusion in accordance with Resolution 8 of the 23rd CGPM (2007). Dr Laiz added that there has been no contact between SENCAMER, the Venezuelan NMI, and the Inter-American Metrology System (SIM) since 2011.

Mr Henson remarked that there were no other outstanding Member State contributions dating back for more than two years. He reported on the payment status of the Associates, and said that only Jamaica and Yemen have outstanding subscriptions dating back to 2015. In addition to these two Associates, Cuba has an outstanding subscription for 2016. Both Jamaica and Yemen will be excluded on 1 January 2018 if no payment is received beforehand as they will then have been in arrears for three years. Jamaica is at the top of the escalator but has indicated that it cannot justify the current subscription of 50 k€ per year nor the 56 k€ contribution as a Member State. He said that Jamaica's case will be discussed later in the agenda in §18.

Mr Henson gave a brief update on the status of Associate States that have been encouraged to accede to the Metre Convention and become Member States (the 'escalator' mechanism). He went on to outline discussions with two states planning to become Associates. Ethiopia has now completed all the necessary steps and will become an Associate State of the CGPM on 1 January 2018. Dr Louw commented that Ethiopia has been working with the NMISA for 10 years. It has received World Bank funding to set up new laboratories and the NMISA has been contracted to help it establish a reference material facility. Tanzania is also expected to become an Associate State of the CGPM from 1 January 2018, subject to completing formalities.

The President thanked Mr Henson and noted that subscriptions from Associates now total around 1 M€ per year, which is evidence of the success of the Associate status. He also noted with satisfaction that, with the exception of the two cases just discussed, there was no Member State more than two years in arrears, and the payment situation was significantly better than in recent years. Mr Henson said that thanks should also be recorded for Ms Fellag Ariouet and Ms Guliyeva for their hard work in contacting Member States and Associate States to ensure that payments were made on time.

7. EXCLUSION OF MEMBER STATES IN ARREARS

The Director said that, in advance of the 26th meeting of the CGPM, it would be useful for the CIPM to consider the evolution of historical practices towards Member States in arrears, and whether action was needed.

Mr Henson referred to Article 6 paragraphs 6 to 8 (1921) of the Regulations annexed to the Metre Convention. The provisions are clear. A defaulting Member State is suspended after three years in arrears and excluded after a further three years in arrears. However, the above notwithstanding, historical practice was not to exclude Member States defaulting for more than six years. Ms Arlen remarked that there is a general tendency in all international organizations to avoid exclusions based solely on arrears if it is possible to do so.

Mr Henson went on to explain that this practice had resulted in arrears for some defaulting Member States accumulating for decades. During this extended period all advantages and prerogatives conferred by accession to the Metre Convention were suspended for defaulting states and their contributions were distributed among other Member States.

The President recalled that in the past, there had been confusion over who was ultimately responsible for excluding a Member State that had exceeded the six-year cut-off point for accumulating arrears. The situation

had become unclear as to whether it was the French Ministry of Foreign Affairs, the CIPM or the CGPM itself that was responsible. As a result, the decision to exclude had not been taken in some cases.

Mr Henson continued by explaining that Resolution 8 of the 23rd CGPM (2007) ended the historical practice by which defaulting Member States continued to build up arrears over decades. However, this Resolution introduced the concept of a time frame beyond six years to agree a rescheduling arrangement, and eventually specifically required a decision in each case by the CGPM before a Member State in arrears can be excluded. In practice the need for an explicit CGPM decision is not helpful. The requirement introduces the possibility of default beyond six years, and the exact period depends on the scheduling of the CGPM meetings. Thus defaulting Member States may not be treated equally.

The President said that there would be some merit in reverting to the direct application of Article 6 for all Member States in arrears, with a procedural step through the CIPM. This would bring clarity for all parties.

The Director remarked that the CIPM was being asked to consider giving their approval to the development of a draft resolution for the CGPM. Mr Henson introduced some text that had been discussed with the CIPM bureau.

He suggested a draft Resolution might include the following key points:

The CGPM….

confirms that:

- *an excluded Member State may only again accede to the Metre Convention if its remaining arrears have been paid,*
- *pursuant to Article 11 of the Metre Convention, that such a Member State shall pay an entrance contribution equal to its first annual contribution,*

decides that

- *a State that is six years in arrears in its contributions shall be excluded upon decision of the CIPM,*
- *the CIPM shall undertake a review of the BIPM financial reports with a view to rectifying the accounts in any case where the treatment of a Member State has resulted in unjustified arrears.*

The Director added that the draft resolution would amend Resolution 8 of the 23rd CGPM (2007), removing the inconsistency of treatment arising from the periodicity of CGPM meetings.

Mr Henson added that if this approach were adopted, it would be logical to reconsider the arrears stretching back over decades which had accumulated because of the failure to apply Article 6. Mr Henson recalled that the agreed dotation is parted among the Member States, and that arrears are distributed among the other Member States pro-rata to their own contributions. As such, the total annual payment by each Member State would have been exactly the same had the defaulting State(s) been excluded.

The Director was asked to elaborate upon what was meant by ‘a review of the BIPM financial reports’ in the second bullet point under ‘decides’. He explained that the review would look at how the period after suspension of a State would be shown in the accounts.

It was recalled by the President that the French Ministry of Foreign Affairs will still need to be involved in informing the Member States of exclusion and this should be taken into account in the development of the draft resolution. The Director said that a meeting has been scheduled with the French Ministry of Foreign Affairs to discuss the issue. It was agreed that development of the draft resolution regarding the process for the exclusion of Member States in arrears should continue.

Decision CIPM/106-04 The CIPM decided to draft a resolution for submission to the 26th meeting of the CGPM regarding the process for the exclusion of Member States in arrears.

Ms Arlen and Ms Guliyeva left the meeting and Mr Henson left temporarily during the *in camera* session.

8. THE BIPM PENSION AND PROVIDENT FUND

Item 8 was held *in camera*. Dr Liew joined the meeting during item 8.

Report from the President of the Pension Fund Advisory Board (PFAB)

Mr Érard gave his report on the BIPM Pension and Provident Fund and the steps being taken to address its long-term financial stability. He summarized the progress made since Resolution 3 of the 25th CGPM (2014), which had invited the CIPM to "*implement its plans to provide sustainability for the BIPM Pension and Provident Fund whilst continuing to examine the longer term liability issue*."

He presented a graph showing the effects of implementing a pension freeze on the assets of the Pension and Provident Fund from 2016 to 2056. He recalled that the proposals put forward in October 2016, which included a higher contribution rate for staff recruited after 1 January 2017 and increases in the contributions from all current staff, had been agreed by the CIPM following Decision 105-06. These measures were introduced on 1 January 2017. He said that the CIPM should return to the proposal for a "pension freeze" later in the meeting. He confirmed that a full actuarial review is being planned for 2019.

Mr Érard continued by presenting the results of a study by Mercer into the investment strategy for the pension fund assets, with projections to 2037. The study had confirmed the current choice of investment strategy. He said that the next steps are to set up an *ad hoc* Investment Committee which will meet with the investment managers to review their fees and strategy.

Discussion of options for further reform of the PFAB

Mr Érard went through the next steps towards the reform of the PFAB. The first was to involve pensioners and deferred pensioners in the PFAB following CIPM Decision 105-09. As an interim measure pending a formal CIPM decision, the President of the PFAB and the Director had agreed to involve one representative of the pensioners and deferred pensioners at the PFAB as an observer. In order to do this, the BIPM contacted all existing pensioners to ask for the nomination of potential candidates. Only one candidate, Dr Witt, was proposed and he was duly elected by the PFAB.

Mr Érard commented that the CIPM now needed to change Title IV of the Regulations of the Pension and Provident Fund relating to the PFAB to formalize the involvement of the representative of pensioners and deferred pensioners as a member of the PFAB elected for a 4-year term. He asked the CIPM for comments. The Director said that this proposal had been communicated to the *Commission des conditions d'emploi* (CCE) for their advisory opinion. Their opinion was that the change should only take place in the context of a whole set of changes to the membership of the PFAB that they had proposed. After considering this opinion, the CIPM agreed to the change.

Decision CIPM/106-05 The CIPM decided to modify Title IV of the Regulations of the Pension and Provident Fund relating to the Pension Fund Advisory Board to add to its membership one representative of pensioners and deferred pensioners of the BIPM, elected for 4 years.

Mr Érard recalled the measures that have been implemented by the CIPM to support the long-term sustainability of the Pension and Provident Fund, including increased contributions into the pension fund by the BIPM and the staff. He noted that Mercer had also modelled the introduction of a pension "freeze" for the period 2018-2019.

He commented that such a "freeze" meant that the pensions would not be adjusted for changes in the cost of living in 2018 and 2019. This would require a change to the definition of the *point*. The preferred way to do this would be to introduce a new "*Pension Point*" that would be specifically applicable to the calculation of pensions and would no longer be equivalent to the "*point"* that would continue to be used to calculate BIPM salaries and allowances.

The President said that the proposal had been submitted to the CCE for their advisory opinion. They had replied that since it is linked to the sustainability of the pension fund "we do not recommend that this modification be done without being thoroughly discussed with the modified PFAB".

The Director said that the BIPM had taken legal advice which had been reviewed by the Presidents of the CIPM and the PFAB. This had confirmed that it is accepted that organizations could abate cost of living adjustments for pensioners in circumstances where there is a financial need to do so. He said that a decision is required by the CIPM to define the new "pension point". He recalled that the CIPM has taken the position that existing pensioners should not be affected by any changes to the pension fund. However, in discussion with members of the CCE, the view had been expressed that pensioners should somehow contribute towards the financial sustainability of the fund.

The discussion focused on the fact that difficult decisions were needed to address the long-term sustainability of the fund. It was clarified that the proposal for a two-year pension 'freeze' would cover the period until the actuarial review planned for 2019. It was noted that the calculations for the projected development of the pension fund depend on the current discount rate, which could vary by the time of the next actuarial review.

The President presented two draft decisions that would split the *point* and freeze pensions for 2018-2019. After a brief discussion, the decisions were adopted unanimously with the following text.

Decision CIPM/106-06 The CIPM decided unanimously to modify the Rules of the BIPM Pension and Provident Fund to state that the unit used to calculate pensions shall henceforth be the *Pension Point* and that the CIPM may, if the need to ensure long-term financial sustainability warrants so, phase in the adjustment of the *Pension Point* value, apply it in part, suspend it or defer it. (The modification is applicable to all three Sections of the Fund: Pre-2010, Post-2010 and Post-2017.)

Decision CIPM/106-07 Following review of the actuarial modelling carried out by the actuaries at Mercer, and Decision CIPM/105-06 by which the CIPM:

- increased the annual contributions by the BIPM to the Pension Fund by 400 k€ in 2017 and 150 k€ in every year thereafter, and
- implemented increases in the contribution rate for active staff

The CIPM decided unanimously that the *Pension Point* will not be adjusted for the period 2018-2019.

The President noted that the bureau had agreed informally to convey some of the views of BIPM staff expressed to it at a meeting with the CCE. He said that the BIPM staff had requested parity in terms of representation on the PFAB. This would involve increasing the number of representatives from one to three. It was recalled that in 2016 the CIPM had discussed the general principle that representation on the PFAB should reflect the balance of financial inputs of the different parties involved. A comparative table of pension fund governance at the BIPM and the United Nations (UN), European Organization for Nuclear Research

(CERN)/European Southern Observatory (ESO) and European Patent Office (EPO) was presented and discussed.

It was noted that the PFAB is only an advisory body which does not have executive powers.

The President recalled that the CCE had requested the possibility of appointing an external expert to the PFAB, to balance the appointment of an expert by the CIPM. The bureau had considered this proposal and it was of the opinion that this would not be appropriate since the expert appointed by the CIPM was independent and played a role similar to being a "Member State" representative. After discussion, the CIPM agreed the following decision unanimously.

Decision CIPM/106-08 The CIPM decided to increase the number of serving staff elected by the staff to the PFAB from one to three, each serving a term of 4 years. It will continue, when possible, with the practice of engaging an external expert on the PFAB drawn from amongst the representatives of the Member States.

9. REPORT FROM THE CIPM *AD HOC* WORKING GROUP ON CONDITIONS OF EMPLOYMENT

Item 9 was removed from the agenda as the Working Group had not met since the last meeting of the CIPM.

10. REPORTS FROM THE CCU AND CCM ON PROGRESS TOWARDS THE POSSIBLE REDEFINITION OF THE SI

The meeting was joined by Mr Henson, Dr de Mirandés, Dr Quinn and Prof. Wallard.

Prof. Ullrich said that the 23rd CCU meeting held on 5-6 September 2017 had been very productive and included a survey from the NMIs on prospective progress on primary realizations of the kilogram until the end of 2017 and the end of 2020.

He presented the latest results for the measurement of the Boltzmann constant. The requirements for consistent data and one measurement with an uncertainty below 3×10^{-6} from at least two independent methods have been fulfilled (dielectric constant gas thermometry at the PTB and noise thermometry at the NIST and NIM in addition to acoustic gas thermometry) and taken into account in the CODATA Least Squares Analysis (LSA). Prof. Ullrich commented that data on Boltzmann constant measurements using a quasi-spherical acoustic resonator, which had been undertaken by researchers in Russia, had only been brought to the attention of the CODATA Task Group on Fundamental Constants (TGFC) after the 2017 CODATA Special Adjustment had been completed, submitted for publication and disseminated to the CCU for discussion. Based on discussions within the TGFC and with experts in the field of acoustic gas thermometry, the TGFC decided not to include this research effort in the 2017 CODATA Special Adjustment.

Prof. Ullrich recalled that the Consultative Committee for Thermometry (CCT) had approved Recommendation T1 (2017) "For a new definition of the kelvin in 2018" at its 28th meeting (1-2 June 2017). It recommended that the CIPM finalize the unit redefinitions through agreeing to fix the values of the fundamental physical constants, from which a fixed numerical value of the Boltzmann constant with eight digits will be adopted for the redefinition of the kelvin, and that Member State NMIs take full advantage of the opportunities for the realization and dissemination of thermodynamic temperature afforded by the kelvin redefinition and the *mise en pratique* for the definition of the kelvin.

For the Planck constant (h) the data considered by the CODATA LSA were not consistent. Prof. Ullrich noted

that an independent expert opinion had been sought from Dr Bich, Convenor of the JCGM Working Group on the Expression of Uncertainty in Measurement (GUM), who had commented that the word 'consistent' had disappeared from CCM Recommendation G1 (2017) but was still implicitly there as a function of other requirements. Dr Bich provided definitions of 'independence' and 'consistency' for which no guidance is given in the GUM. Consistency could never be considered in absolute terms and would always be dependent on the choice of consistency test. Dr Bich then considered the data sent to CODATA. All the data, as received, were not consistent according to the criteria he had set and had a Birge Ratio of 1.92, well above the critical level of 1.24. When the three data points with the lowest uncertainty were considered (NIST-17, NRC-17 and IAC-17) the inconsistency remained. However, the CODATA LSA uses an expansion factor of 1.7 and when the analysis was performed on the data with the uncertainties increased by this factor, there was total consistency with a Birge ratio of 1.12, which is below the critical level of 1.24. In addition, even with the expansion factor there are now two values with a relative uncertainty below 2×10^{-8} when only one was requested and there are five values with a relative uncertainty below 5×10^{-8}, which was also requested by the CCM. Moreover, these results were achieved using more than two different methods. Therefore, the conditions set by the Consultative Committee for Mass and Related Quantities (CCM) have been fulfilled when using an expansion factor of 1.7.

The stakeholders were consulted to check if the results for measuring *h* were acceptable. OIML Recommendation R111 for weights of class E_1 requires a relative uncertainty of $\leq 8.3 \times 10^{-8}$ and typically these weights of class E_1 are calibrated by the NMIs. For that, the NMIs should have an uncertainty that is a factor of three better than the laboratories that have E_1 mass standards. It is expected that the NMIs will be able to provide calibrations with an uncertainty of around 3×10^{-8}. There has been some concern among the stakeholders regarding the consistency of results and the need for stable values, equivalent world-wide, and that these must be available to all users. For critical applications the community cannot afford to see differences from region to region. Until the results are more consistent it was agreed that, after the redefinition of the SI, a temporary consensus value should be used in the dissemination of the unit of mass.

The CCM has considered the future stability of this consensus value. Dr Bich concluded that the six values of *h* from the adjustments provided by CODATA since 1998 did not show good consistency. Since 2010, the last three values showed better consistency, exceeding the 95 % confidence level and almost passing the Birge criteria. Prof. Ullrich commented that there have been comprehensive discussions on how to ensure stability of the consensus value in the future and how it will be defined. CCM Recommendation G1 (2017) "For a new definition of the kilogram in 2018" requests those NMIs having a realization of the kilogram to avail themselves of the consensus value (as determined from the ongoing comparison of primary realizations). He added that the exact definition of the consensus value is not clear. Dr Richard recalled that discussions on the temporary use of a consensus value had taken place at the CCM meeting. The adoption of a consensus value would mean that realization experiments would disseminate the consensus value instead of their own value by applying a correction to their locally realized mass unit, until the dispersion of results was compatible with individual realizations. The consensus value would be obtained from a periodic comparison of all realization experiments. It would be broadly equivalent to a key comparison reference value. A clear procedure is needed and this should be mentioned in the *mise en pratique* and explained in a CCM document.

Prof. Ullrich paused for questions. It was asked upon whose authority the CODATA TGFC had decided to not include the Russian data on Boltzmann constant measurements. Prof. Ullrich replied that it had been a combined decision by the CODATA TGFC and the CCT. Clarification was requested on whether inclusion of the Russian data would have had an impact. The answer was that it would have had no impact as the figures will be rounded up to seven digits, and the impact would have only been on the eighth digit.

Prof. Ullrich handed over to Dr Richard to give the report from the CCM. Dr Richard said that all the steps on the Joint CCM and CCU roadmap for the revision of the SI have been achieved and he recalled the CCM

conditions for proceeding with the redefinitions. The CCM discussed progress towards fulfilling the conditions at its 16th meeting (2017), held on 18-19 May, and Dr Richard expanded on the information given by Prof. Ullrich regarding measurements of *h*. The requirement for consistency among three independent experiments from at least two different methods (XRCD and Kibble balance) each with a relative uncertainty of $u_{\mathrm{rel}} < 5 \times 10^{-8}$ has not strictly been fulfilled, but is fulfilled with an uncertainty expansion of about 30 % to force consistency. It was noted that, even with the expansion factor, the uncertainty of the three measurements remained below the target value ($u_{\mathrm{rel}} < 5 \times 10^{-8}$). The request that the uncertainty of at least one result is $u_{\mathrm{rel}} < 2 \times 10^{-8}$ has also been fulfilled, even with the application of the expansion factor. Traceability to the IPK through an extraordinary calibration has been achieved and the close-to-final version of the *mise en pratique* was approved at the last CCM meeting. The results of the analysis at the 16th CCM meeting were included in CCM Recommendation G1 (2017). This Recommendation considers that as many determinations of the value of *h* as possible should be considered. He commented that the conclusion of the CCM was that the consistency of the results is suitable, even for the most demanding applications, which addresses the concerns of stakeholders. CCM Recommendation G1 (2017) requests the NMIs to use the consensus value for the dissemination of the mass unit and recommends that the CIPM undertakes the necessary steps to proceed with the planned redefinition of the SI at the next meeting of the CGPM. The temporary use of a consensus value for the dissemination is explained in the *mise en pratique* of the definition of the kilogram, the paper "Maintaining and disseminating the kilogram following its redefinition"[2] and the "Short note on the dissemination process after the proposed redefinition of the kilogram". Dr Richard recalled that CCM Recommendation G1 (2017) was the result of a compromise obtained after long discussions during the 16th CCM, with a strong minority against. The compromise was reached so as not to slow down the redefinition process.

He presented schematics showing the current and future traceability routes for the kilogram and the proposed dissemination routes. The timeline for dissemination and using the consensus value consists of four phases. Phase 0 is the present traceability using the IPK and this will continue until 19 May 2019. The uncertainty comes from the dissemination process and present stability of the mass standards. Phase 1 will consist of the present traceability, but will take into account the additional uncertainty coming from the new definition. Phase 1 will begin on the implementation date of 20 May 2019 (World Metrology Day) and will continue until the first consensus value is defined by the 18th CCM: this is expected in the first quarter of 2020. Dissemination will be via the IPK but with $u_{\mathrm{mIPK}} = 10$ µg (the uncertainty associated to the mass of the IPK right after the redefinition. The uncertainty of the adjusted value of *h* of 1 part in 10^8, prior to the redefinition, will be attributed to the mass of the IPK right after the redefinition). Phase 2 is the dissemination of the consensus value and will begin after it has been defined. The source of traceability in Phase 2 will be the consensus value. Each NMI with a primary realization facility will have to carry out a correction and a CCM Task Group will be established to define the exact consensus value, based on the output of a statistical analysis of all the data from available realizations of the kilogram and knowledge of stability of the current mass dissemination. Phase 2 will start in first quarter 2020 and will end when the CCM decides that sufficient consistency has been reached: dissemination will be possible via the individual experiments and the consensus value will no longer be needed. When this occurs, Phase 3, dissemination of individual realizations, will begin. The source of traceability in Phase 3 will be the fixed value of *h* with no uncertainty. The uncertainty of BIPM mass calibrations will become the uncertainty of the KCRV of the primary realization key comparison plus the uncertainty of the stability of the ensemble of reference mass standards (ERMS). The President thanked Dr Richard and asked for questions and comments.

It was recalled that it is unknown by how much the mass of the IPK has changed since 1889. The uncertainty of BIPM mass calibrations is 5 µg with respect to the IPK as it is today, not the value from 1889. Prof. Ullrich

[2] Stock M., Davidson S., Fang H., Milton M., de Mirandés E., Richard P., Sutton C., Maintaining and disseminating the kilogram following its redefinition, *Metrologia*, 2017, **54**(6), S99-S107.

added that the magnitude of the change is unknown because previous measurements of the Planck constant have been more uncertain than the stability of the IPK, although the two are now converging. He asked for more clarification of the consensus value and what would happen if new experiments become available that give results that are significantly different to the consensus value, resulting in large 'jumps' in the value. Dr Richard said that large jumps are not expected and questions such as this will be handled by the CCM Working Group on the Dissemination of the kilogram (CCM-WGD-kg). He added that two types of weighting are described in the *Short note on the dissemination process after the proposed redefinition of the kilogram*. The first is the creation of the KCRV and this will be supplemented by specific comparisons that will be carried out when a new value becomes available. It was suggested that the new experiments are not fully independent of the IPK as it is used to establish *h*, therefore it appears that the kilogram is being 'fixed' through the use of *h*. If this were not the case, a mass traceable to the IPK would not be required in Kibble balances. In response it was pointed out that the day after the redefinition, the kilogram will no longer be traceable to the IPK. It was proposed that in the future there should be confidence that the consensus value will not drift. This will depend on the existence of Kibble balances with sufficient accuracy and further advances in technology. Concerns were raised about the consensus value and the possibility that this may cause anxiety among the user community for the kilogram and the suggestion that in Phase 1 NMIs may have to revise the uncertainties on previous certificates. The extent and scale of these revisions was questioned because the re-issuing of certificates could cause concerns among the NMIs and a carefully worded statement may be required from the CCM. Dr Richard commented that the CCM will choose the right consensus value and the changes to mass certificates will not affect any NMIs. The change is only 10 μg and the NMIs use 50 μg as a benchmark. It was asked if there is a limit to the uncertainty that needs to be demonstrated in order to contribute to the KCRV and if there is a framework to provide guidance on the expertise that needs to be demonstrated in order for an NMI to contribute. The limits to contribute could be the same as those used by CODATA and expertise to contribute could be reviewed by the CCM. The Director said that the consensus value has been mentioned and KCRVs are very familiar through the operation of KCs under the CIPM MRA. The KCRV will be introduced in Phase 3; however it will be a 'snapshot' of the best estimate of the state of play when the KC was carried out. It does not have an intrinsic property of stability and in this respect the CIPM MRA will become very important in how mass traceability is disseminated in Phase 3. In Phases 1 and 2 something different will be needed, and this is why the consensus value has been proposed. The consensus value is a new concept and will be different to the KCRV. It will have the property of retaining stability, which is not necessarily the case with KCRVs. This could be achieved by excluding outliers, as is the case with CODATA, based on uncertainty and not on displacement from the central value. KCRVs are very sensitive to extreme points with small uncertainties. In addition, the BIPM ERMS has a stability that is understood and which has been well modelled. This could bring a strong element of stability into the system and provide a benchmark that will be taken over by Kibble balances and other primary realizations as they improve. The uncertainty of the BIPM standards is relevant and should be included in the consensus value. Discussions will be required in advance of the next CCM meeting to ensure that the mass community is on board with an approach that is understandable, and in order to build confidence that the proposals for dissemination are as good as, if not better, than the present system. Dr Richard noted that criteria or limits will be required to move from Phase 2 to Phase 3. These were defined in previous CCM recommendations but still need to be provided. It was suggested that the trigger could be when the primary realizations are better than the BIPM standards.

Prof. Ullrich presented the draft of a decision asking the CCM to provide, for the next meeting of the CIPM, a formally approved note on the dissemination process after the redefinition of the kilogram, addressing in particular the definition of the consensus value, as well as an updated *mise en pratique*. There was a discussion on the wording and the decision was approved. Dr Richard said that formal approval by the CCM will be by correspondence.

Decision CIPM/106-09 The CIPM requested the CCM to provide, for the next meeting of the CIPM, a formally approved note on the dissemination process after the redefinition of the kilogram, addressing in particular the definition of the consensus value, as well as an updated *mise en pratique*, taking into account the comments made at the 106th meeting of the CIPM.

Prof. Ullrich presented CCU Recommendation U1 (2017) "On the possible redefinition of the kilogram, ampere, kelvin and mole in 2018" which recommends "that the CIPM undertakes the necessary steps to proceed with the planned redefinition of the kilogram, ampere, kelvin and mole at the 26th CGPM in 2018." The CIPM supported CCU Recommendation U1 (2017) and the following decision was agreed.

Decision CIPM/106-10 The International Committee for Weights and Measures (CIPM) welcomed recommendations regarding the redefinition of the SI from its Consultative Committees.

The CIPM noted that the agreed conditions for the redefinition are now met and decided to submit Draft Resolution A to the 26th meeting of the General Conference on Weights and Measures (CGPM) and to undertake all other necessary steps to proceed with the planned redefinition of the kilogram, ampere, kelvin and mole.

Prof. Ullrich gave a brief summary of the reports from the NMIs and their future plans towards the redefinition of the SI. He displayed the questions sent to NMIs in the CCU survey regarding their plans. The NMIs have reported their expected uncertainty before the end of 2017 in the determination of the Planck constant: METAS 5×10^{-8}, NPL 1×10^{-7}, BIPM 1×10^{-7}, NIM n $\times 10^{-7}$ and KRISS 5×10^{-7}. It was asked if the PTB expects to gain any insight into its discrepant value of *h*, derived from its silicon sphere measurements, before the end of 2017. Prof. Ullrich replied that the values are not discrepant but agree within their uncertainties and that there will be more input, however the issue is not expected to be resolved before the end of 2017 as the PTB has only one lattice value parameter. The possibility of the shift in the PTB results impacting on the results from NMIJ was queried, since both measurements were related. Prof. Ullrich recalled that the NMIJ value is derived from a new crystal and was of the opinion that the value is borderline but not discrepant. At the level of 30-40 μg, there may be systematic uncertainties related to the solid-state physics of the crystals, such as defects or carbon impurities that are not yet under full control. New Si crystals will be available in 2018 and three independent values will be obtained for the first time from independently grown crystals. This may improve the situation. Prof. Ullrich was asked if there is much difference between the results obtained between the old (XRR, XRF and spectroscopic ellipsometry) and new (combined XPS and XRF) surface analysis methods used to analyse the Si spheres at the PTB. He replied that there is a systematic difference of about 1×10^{-8}. Dr Richard said that METAS will publish its value for *h* by the end of 2017.

Dr Richard presented some considerations on the proposal to change the closing date for the publication of results to be taken into account in the special CODATA adjustment to the end of 2017. He recalled the current position: the CCM requirements have been globally met and future key comparisons on realization of the kilogram and the use of the consensus value guarantee that potential inconsistencies in mass metrology between national standards can be avoided after the redefinition of the kilogram. However, new aspects in the Avogadro (silicon) sphere data have not been completely resolved and more Kibble balance data are expected in the near future; in particular METAS confirmed the publication of a new value before the end of 2017. A possible way forward would be to change the closing date for the publication of results that are to be taken into account in the special CODATA adjustment. The arguments for and against changing the closing date were presented. Dr Richard said that he was requesting a change of the closing date from 1 July 2017 to 31 December 2017 and a revision of the Joint CCM and CCU roadmap. He recalled that this would not contradict CCM Recommendation G1 (2017) or CCU Recommendation U1 (2017); it would provide the possibility of having some answers to the remaining discrepancies between the results of XRCD and Kibble balance experiments as well as having at least one additional value for the determination of *h*; the CIPM would

still be able to put the final numbers in the Draft Resolution (at the time of the CGPM Convocation); and there would be no impact on the redefinition process. Dr Richard recalled that the implementation date for the revised SI had been changed to 20 May 2019, six months later than that proposed on the roadmap. He asked for clarification as to whether the proposed change to the closing date for the publication of results would have any practical implications for the 26th CGPM. It was confirmed that although there were no practical implications, by including the final data in the Convocation a 'good signal' would be sent to the Member States.

He invited questions and comments. There was a comprehensive discussion with a majority view that extending the deadline was not necessary as it would not have a significant effect on the figures and any discrepancies were unlikely to be solved during the extra six months. Prof. Ullrich recalled that this matter had been discussed in the CCU meeting and the timetable being followed is that outlined in the Joint CCM and CCU roadmap, which was agreed by the CIPM. It was pointed out that if the NMIs had known that the deadline was to have been extended, they may have done things differently. In addition, extending the deadline would be unreasonable as some of the stakeholders had to change their research priorities to meet the deadline. The Director suggested a compromise whereby the current deadline could be retained and the data scheduled to be submitted by METAS at the end of 2017 could be used as the first data point after the end of the LSA to add to and confirm the consistency of the CODATA figures. The President called for a show of hands on whether to retain the existing closing date (1 July 2017) for the publication of results to be taken into account in the special CODATA adjustment, or to delay until 31 December 2017. There was a majority to retain the original deadline of 1 July 2017.

Decision CIPM/106-11 The CIPM authorized the CIPM President to convey its support for the publication of the final numerical values for the defining constants to the Task Group for Fundamental Constants convened by CODATA.

Prof. Ullrich presented the revised Draft Resolution A "The International System of Units (SI)" to be presented to the 26th CGPM (2018). He added that this version has only been changed to include the modified wording for the definition of the mole as well as the final CODATA LSA values for the defining constants. The modified definition of the mole, which was proposed by IUPAC and has been discussed by the CCQM and the CCU, was as follows:

"The mole, symbol mol, is the SI unit of amount of substance. One mole contains exactly 6 022 140 8Y × 10^{23} elementary entities. This number is the fixed numerical value of the Avogadro constant, N_A, when expressed in the unit mol^{-1} and is called the Avogadro number.

The amount of substance, symbol *n*, of a system is a measure of the number of specified elementary entities. An elementary entity may be an atom, a molecule, an ion, an electron, any other particle or specified group of particles."

The CIPM discussed the modified wording of the mole and there was general support. The proposed new wording is considered to be more understandable by the user community in chemistry. Prof. Ullrich continued by presenting the final CODATA LSA values for the defining constants and an additional paragraph that includes explanatory text on the hertz, joule, coulomb, lumen and watt. This explanatory paragraph was accepted by the CCU and is included in Resolution 1 of the 24th CGPM (2011), giving a link to Draft Resolution A. He recalled that there had also been a change to the order of the text in the definition of luminous efficacy. Following a brief discussion, the CIPM accepted the revised Draft Resolution A as presented by Prof. Ullrich.

Decision CIPM/106-12 The CIPM accepted the revised Draft Resolution A as presented at the 106th meeting of the CIPM, which included modifications:

- to the wording for the definition of the mole as suggested by the CCU and based on proposals by the CCQM and IUPAC,
- to include the final CODATA LSA values for the defining constants,
- to rearrange the order of the sentence in the definition of the luminous efficacy, and
- to include explanatory text on the hertz, joule, coulomb, lumen and watt.

Prof. Ullrich presented the 9th edition of the SI Brochure, as modified by the editing team and approved by the CCU, for approval by the CIPM. He summarized the main modifications and noted that the editing team had requested the addition of the preface on "The BIPM and the Metre Convention" as used in the 8th edition of the SI Brochure and modified by updating the number of Member States and Associate States/Economies. Adding the preface would allow the deletion of the former Appendix 1 on "The Metre Convention and its Organs". The proposed text for the preface was displayed. Following a discussion, the CIPM agreed with the proposed modifications and approved the edited version of the 9th edition of the SI Brochure with the addition of the preface on "The BIPM and the Metre Convention" used in the 8th edition.

Decision CIPM/106-13 The CIPM approved the edited version of the 9th edition of the SI Brochure, as approved by the CCU, changed by adding the preface on "The BIPM and the Metre Convention" used in the 8th edition of the SI Brochure modified only by correcting the numbers of Member States and Associate States/Economies and simultaneously deleting what was Appendix 1 on "The Metre Convention and its Organs".

Prof. Ullrich briefly presented the "Concise summary of the International System of Units, SI", which had been developed and edited by the editing team. It was noted that the CIPM had been omitted from the concise summary: this oversight will be corrected. He thanked the editing team for their work and concluded his presentation by mentioning the symposium "The Fundamental Constants of Physics", which had been held at the end of the CCU meeting on 7 September 2017. The Director said that one of the speakers at the symposium, Jean-Philippe Uzan, may be invited to speak at the 26th CGPM.

11. UPDATE ON THE CIPM TASK GROUP FOR PROMOTION OF THE SI

Prof. Ullrich recalled the structure and objectives of the CIPM Task Group for Promotion of the SI. The Task Group has a dedicated webpage that includes the SI Brand Book, SI illustration guidelines and graphics files, which are available to download. The SI download area also includes infographics for use by specific audiences. It develops promotional material for sharing with the metrology and wider community. He said that copyright for any material shared in the webpage must be owned by the NMI that has developed it and each NMI will be asked to choose a generic Creative Commons License (CC BY 4.0) for each document that they want to have uploaded. This should allow users to copy and transform material but they will be required to credit the original authors and inform them if any modifications have been made. There are seven other Creative Commons Licenses that provide variations such as restricting the ability to modify original work. The contents of the final version of the "SI Brand Book" for the future revision of the SI were presented. The main actions for the Task Group in 2017 have been met, including the development of a common statement from the CCs. The collaboration with EURAMET to plan the poster for World Metrology Day 2018 is ongoing: the topic is "Revision of the SI". In addition, filming has started for "The last artifact", a 60-90 minute film sponsored by a major grant from NIST. It will be distributed in late 2018/early 2019.

In 2018 the Task Group will enter the campaign phase. This phase will include issuing version 2 of the SI Brand Book and providing a PR launch pack for World Metrology Day. The planned celebrations for the revision of the SI at the 26th CGPM will be further developed. The NMIs will be encouraged to share their plans and implement local campaigns and the Task Group will develop materials to mark the close of the campaign in 2019. The next meeting of the Task Group is scheduled for 18 January 2018. The President thanked Prof. Ullrich and the members of the Task Group for the excellent work they have done so far towards the promotion of the revised SI.

A question was raised about whether Member State governments will be encouraged to promote the revised SI, as they have legislation that reflects the SI, especially in support of trade. Prof. Ullrich commented that this will be raised at the next meeting of the Task Group. It was asked if the UNIDO Sustainable Development Goals (SDGs) have been considered in relation to promotion of the revised SI, as they are linked to measurements. The Director commented that the BIPM has worked with UNIDO to develop a brochure that illustrates the contribution of metrology to the SDGs, which is being promoted by UNIDO. The brochure will be presented later in the agenda.

Decision CIPM/106-14 The CIPM welcomed the excellent progress on the promotion of the revised SI by the CIPM Task Group for Promotion of the SI and encouraged all NMIs to take advantage of the material they develop.

THE 106TH MEETING OF THE CIPM – SECOND DAY – 17 OCTOBER 2017

The President welcomed the CIPM to the second day of its meeting, which was joined by Dr Arias, Dr Fang, Mr Henson, Dr Judge, Dr Panfilo, Dr Picard, Dr Quinn, Dr Robertsson, Dr Stock, Dr Viallon and Dr Wielgosz.

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

BIPM Chemistry Department

Dr Wielgosz gave an overview of the structure and staff of the department. There are currently 10.5 full-time staff and there have been a number of changes since the last meeting of the CIPM. Mr Idrees is now working full-time in the gas metrology area, having previously worked 50 % in the Physical Metrology Department. Dr Stoppacher has left the BIPM, to be replaced by Dr Martos, who will start in late October 2017 and will work in the organic analysis area. In addition, Dr Viallon has been appointed as the Executive Secretary of the CCPR, noting the liaison activities that she was already fulfilling with the World Meteorological Organization (WMO). He commented that the department has hosted a considerable number of visiting scientists from the NMIs. In 2017 there have been 20 visiting scientists, equivalent to a total of 7.2 man years of additional activity in the Department. These scientists were split between support for the comparison programme (8) and the capacity building programme (12). Fifteen of the twenty visiting scientists have been funded by their own NMI or through donations. Although the number of visiting scientists has increased, the BIPM resources required to support them has decreased. For example, he noted that the three visiting scientists from the UK were all supported by their home institutes, namely the LGC, NIBSC and NPL.

Since the last meeting of the CIPM the department has had 142 NMI participations in BIPM coordinated comparisons and four BIPM comparisons with measurements performed in the period. A total of five BIPM comparison reports have been published and seven papers were published in peer reviewed journals, with another five in preparation. The department contributed to four normative standards and guidelines and an

additional seven are in preparation. As mentioned, the department has hosted 20 visiting scientists on secondment and a total of five workshops were organized. A brief summary of progress with the 13 key comparisons coordinated by the Chemistry Department was given.

In the gas metrology programme, a comparison of CO_2 at atmospheric levels (CCQM-K120) is under way and is supported by a number of NMIs. It is one of the largest comparisons coordinated by the department and has compared 46 standards from 16 NMIs and DIs. In preparation for this comparison, a paper has been published in *Analytical Chemistry*[3] on how to calibrate instruments to measure the isotope ratios as a consequence of the concentration of CO_2 measured by certain analysers being biased by differing isotopic ratios in gas standards. In addition, visiting scientists from NIST and RISE have been working on the second version of the manometric system to determine the CO_2 mole fraction. The instrument was used by the BIPM in the pilot study linked to the key comparison and will form the basis of an ongoing key comparison in the future (BIPM.QM-K2). The collaboration with the IAEA on new comparisons of CO_2 isotope ratios in gases has started. A facility to mix CO_2 isotopologues to generate samples for comparisons (Stable Isotope Reference Mixture Generator (SIRM-GEN)) has been developed with support from a secondee from NIM (China), who also helped to develop methods to measure the isotope ratios of mixtures of pure CO_2. This work will continue with a comparison to underpin measurements in these areas.

The ongoing comparison of ozone standards (BIPM.QM-K1) was originally set up with NIST in 2000. The standard reference instrument for ozone is ageing and its electronics are out of date. A new system has been developed jointly with NIST and a prototype is operational. It is expected that development of the system will be completed in 2018 and that the upgraded electronics will form the basis for upgrading instruments in the NMIs, allowing them to extend the lifetime of such instruments by 20 years. Dr Wielgosz presented results for the first international comparison on formaldehyde standards (CCQM-K90). Monitoring the concentration of formaldehyde has been carried out using FTIR and he noted that the standards have shown a linear drift while the stability of the standards has been monitored over two years. This has demonstrated the stability of the BIPM measurement system and may be used as a model for future comparisons of semi-stable gases.

In the organic metrology programme the comparison of primary calibrators for diabetes monitoring is ongoing. The results of the work on C-peptide have been published in *Clinical Chemistry*[4]. This paper describes the calibration hierarchy that needs to be applied in order to accurately measure C-peptide in serum. C-peptide is a marker that can be used to differentiate between different types of diabetes and its control. Dr Wielgosz commented that by applying the suggested calibration hierarchy, along with the use of a calibrator that has been value-assigned in serum, better harmonization of measurement results can be achieved among insulin manufacturers.

Within the peptide standards programme there has been progress with future comparisons and the model to be used to underpin measurement capabilities in the area. Work carried out on B-type natriuretic peptide, a biomarker for cardiac infarctions, was supported by a visiting scientist from the LGC (UK) from 15 January to 15 April 2017. B-type natriuretic peptide has a ring-structure, which presented different technical challenges than C-peptide. Work has started on a future peptide comparison programme on haemoglobin A1c (HbA1c) hexapeptides, which is an effective biomarker for monitoring long-term blood glucose levels in diabetic patients. This programme is being coordinated in association with HSA (Singapore), NIM and the LNE. This measurement system can be calibrated by a mixture of two hexapetptide calibrants, one with a sugar molecule and one without. The BIPM will investigate ways to value assign these short peptides and the future comparison will underpin this calibration hierarchy.

[3] Flores E., Viallon J., Moussay P., Griffith D.W.T., Wielgosz R.I., Calibration strategies for FT-IR and other isotope ratio infrared spectrometer instruments for accurate $\delta^{13}C$ and $\delta^{18}O$ measurements of CO_2 in air, *Anal. Chem.*, 2017, **89**(6), 3648-3655.

[4] Little R.R., Wielgosz R.I., Josephs R., Kinumi T., Takatsu A., Li H., Stein D., Burns C., Implementing a reference measurement system for C-peptide: Successes and lessons learned, *Clin. Chem.*, 2017, **63**(10), 1447-1456.

Dr Wielgosz commented that the department's work on small organic calibrators is ongoing. Quantitative NMR (qNMR) is being investigated as a method to value-assign small organic primary calibrators. The technique determines the purity of a compound by measuring relative hydrogen atom concentrations and is independent of the compound being measured. The BIPM has collaborated with the NMIJ to characterize seven standards for qNMR with different solubilities in four major solvents that can be used as a suite of standards to value-assign any pure organic material. The considerable amount of data generated from the qNMR research is being used to produce "Internal Standard Reference Data for qNMR", the first being for maleic acid. These documents will give all the information required by an NMI to use the compound concerned, for example maleic acid, as an internal standard for qNMR. Six further documents will follow to cover the other internal standards.

The department participates actively in the BIPM CBKT programme through the metrology for safe food and clean air projects. Ten NMIs have participated in the programmes so far. The mycotoxin metrology programme started in April 2016 with nine participants at the initial meeting. A further three NMIs, CENAM (Mexico), INRAP (Tunisia) and LATU (Uruguay) participated in the meeting held in April 2017, where future planning was discussed. Five visiting scientists from INMETRO (Brazil), INTI (Argentina), KEBS (Kenya), NIMT (Thailand) and NMISA (South Africa) have been trained during 2017 at the BIPM on how to produce, characterize and value-assign mycotoxin calibrants. A comparison of one of the mycotoxin materials will be organized at the end of 2018 with the NMIs that have participated in the training programme and have subsequently set up their own facilities. Dr Wielgosz thanked the NIM, NMISA (South Africa), UME (Turkey) and PTB for the financial support they have provided for the mycotoxin metrology programme.

The metrology for clean air programme is primarily intended to train visiting scientists in the use of FTIR to value-assign gas standards. The programme was initially funded by the PTB and further funding has been made available by the NPL to pay for the training of three scientists through to 2019 from the NPLI (India), NMISA and KazInMetr (Kazakhstan). The NPL has also funded a set of primary standards for the visiting scientists to work on during their time at the BIPM. These standards will subsequently be transferred to the participating NMIs, along with the knowledge gained by the secondees, to allow the development of in-house capabilities and for the NMIs to participate in future comparisons. The BIPM has produced operating software for FTIR systems (B_FOS), which is made available to the NMIs, giving them a complete solution for the development of clean air standard measurement systems when combined with the knowledge transfer activities.

Dr Wielgosz concluded by presenting the BIPM's proposed coordinated comparison programme in chemistry for 2019 to 2023, which has been included in the CCQM 2017-2016 strategy document. The President thanked Dr Wielgosz for his presentation and commented that the department pursues an impressive work programme. He invited questions and comments.

Dr Wielgosz was asked if the Internal Standard Reference Data for qNMR documents will be published on the BIPM website and how many materials will be covered by the datasheets. He confirmed that they will be made available on the website and reiterated that seven materials will be covered, as this is the minimum required for a suite of standards that will cover most situations when setting up a qNMR facility. It is however possible to add further materials in the future. It was stated that some analytical instrument manufacturers and producers of chemical substances will welcome the publication of these Internal Standard Reference Data for qNMR documents. Dr May remarked that the work at the BIPM on qNMR is of value to the world-wide chemical measurement community.

Joint Committee for Traceability in Laboratory Medicine (JCTLM)

Dr Wielgosz gave a brief overview of the JCTLM for the benefit of the new members of the CIPM. The JCTLM database continues to develop: the number of reference materials has reached a steady state of

around 300 and the number of measurement methods and services continues to increase, reaching 184 and 161 respectively in 2017. When the database content is analysed as a function of analyte it can be seen that there is strong representation from materials, methods and services that are SI-traceable and fewer from those that are traceable to the units of the World Health Organization (WHO). The JCTLM will try to address this situation in its future strategy. Dr Wielgosz was asked why there were a considerable number of reference measurement services in enzymes when compared to the other categories. He replied that enzymes are a specialist area where traceability is established to a reference method. The method measures the rate of loss of a known compound to determine enzyme concentration. The only way to transfer this methodology is via a reference measurement service. He added that there has been a significant increase in the establishment of reference measurement laboratories in Asia, particularly China. He gave a brief overview of the new entries and the materials delisted from the database in 2017.

There has been a significant increase in activity in the area of educating the clinical chemistry community about metrological traceability, driven by the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC). It is hoped that this education initiative will help deliver uniform measurement results across the clinical chemistry sector. The JCTLM WG on Traceability: Education and Promotion (TEP) has set up a dedicated website which includes webinars explaining the importance of traceability to laboratory medicine including physicians and the general public.

Dr Wielgosz commented that the JCTLM Database Newsletter is distributed annually and that it has been well received by the community. He concluded by mentioning the biennial workshop organized by the JCTLM. The title of the forthcoming workshop, to be held at the BIPM on 4-5 December, is "Accurate Results for Patient Care 2017". It will focus on reference measurements for neurodegenerative diseases.

The President thanked Dr Wielgosz and asked who the main users of the JCTLM database are. He replied that there is a spread of users from those that are directly involved through to industry and reference laboratories. The database is sector-driven, so there are a considerable number of users from industry to address their specific needs in traceability. The variability in measurements in analytical laboratories was questioned and whether this is being addressed through legislation or by voluntary actions taken by the analytical chemistry community. Dr Wielgosz replied that the approach depends on the particular country. In Germany for example, the situation is well regulated: there are 40 analytes for which traceability needs to be established. Every three months each analytical laboratory in Germany has to take part in a proficiency testing (PT) scheme and the PT scheme values are set by a higher order reference method. There are tolerances set around this value and falling outside of these tolerances has consequences, such as failure to be reimbursed by insurance companies. He was asked if there has been any progress within the European Commission (EC) towards legislation on the variability of measurements in analytical laboratories. Dr Wielgosz replied that the European Commission *in vitro* diagnostics (IVD) directive became the IVD regulation in 2017. The document mentions metrological traceability six times. He remarked that the JCTLM did not have direct access to the EC on this matter as the JCTLM is not a tool exclusively for European users and is not funded by the EU.

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

Dr May, President of the CCQM, said that the 23rd meeting of the CCQM, held in April 2017, was the largest ever, with more than 230 attendees at the plenary session and Working Group meetings. The CCQM discussed its objectives, which were in line with those of the other CCs. The outcome of the discussions was that its objectives are to document and improve the world-wide comparability of measurements and measurement standards; to improve chemical and biological measurement science; and to provide chemical and biological metrology-related solutions to address important global and societal issues. The last objective is linked to the drive for greater outreach, which is seen as a tool to achieve metrology-related solutions.

He recalled that the biological area within the CCQM had been sub-divided into individual Working Groups in 2015 that cover cell analysis, nucleic acid analysis and protein analysis because the area had become too broad to be covered by a single Working Group. This decision has been vindicated as there are now more than 20 NMIs represented at each of these Working Group meetings.

At the end of May 2017, there were a total of 24 820 published CMCs across all disciplines. Of these, 6226 were from the chemistry and biology disciplines, with participations from 48 countries. At the same time there were 979 key comparison study results across all the CCs. The CCQM had 172 key comparison study results and it had conducted 134 standalone pilot studies. Dr May commented that the CCQM has supported the review of the CIPM MRA to determine how it can manage its workload more effectively, against the background of the rising number of CMCs and KCs.

Dr May commented that the CCQM is concerned that the CIPM MRA serves only the NMI community. It envisions a change so that the MRA becomes a means for NMIs to document and vet the capabilities they maintain to underpin the measurement services they provide to "customers" and for these customers to assess the degree of comparability of a given service across the NMI/DI community. He added that the CCQM approach for contextual implementation of the CIPM MRA involves giving the following message to all existing and new members:

NMI/DI's deliver measurement/metrology services and/or products to customers that are internationally recognized within the framework of the CIPM MRA.

- *CMCs are peer-reviewed descriptions of the capabilities that NMIs/DI's maintain to support consistent delivery of individual services or a class of such services.*
- *Developing and articulating capabilities which do not underpin delivery of measurement/metrology services available to customers is not consistent with the spirit of the CIPM MRA*.

He briefly presented the work in progress on using the "four-track" strategic approach to the harmonization of comparisons across the Working Groups. This approach was developed successfully within the CCQM Working Group on Organic Analysis (OAWG). Examples were given of strategies to manage the number of key comparisons.

Dr May concluded by presenting the decisions and actions from the 23rd meeting of the CCQM and commenting on the development of the CCQM Strategy Document (2017-2026). The document includes evidence of activities from each of the CCQM Working Groups on improving the state of the art of measurement; to support the CIPM MRA; and to support the global metrological community. He added that the CCQM will celebrate its 25th anniversary in 2019. The 2019 CCQM meeting will include a Workshop on Advances in Metrology in Chemistry and Biology and the presentations will be included in a special issue of *Metrologia*. The President thanked Dr May.

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

BIPM Ionizing Radiation Department

Dr Judge, the new Director of the Ionizing Radiation Department, gave an overview of the work of the department and summarized how the BIPM maintains the key comparison reference values (KCRVs) in radiation dosimetry and radioactivity.

He presented the department's work in radiation dosimetry since the last meeting of the CIPM in October 2016. Comparisons have been carried out with the KRISS (Republic of Korea) and the NIM (China) for X-ray standards along with eleven calibrations of national secondary standards. In the area of gamma standards,

comparisons have been completed with the SCK (Belgium) and SMU (Slovakia) and 25 calibrations were undertaken for the NMIs and the IAEA. This work is underpinned by ongoing efforts to maintain and develop the facilities required to provide the KCRVs. New software has been developed to operate the X-ray machines, and the primary standards and transfer instruments continue to be maintained. Dr Judge thanked the BIPM's administrative departments for the support they give to the Ionizing Radiation Department to facilitate the safe and timely world-wide shipping of sensitive instrumentation.

Two highlights in radiation dosimetry since October 2016 have been the development of a new absorbed dose to water primary standard at 100 kV to 250 kV and access to the DOSEO facility. The new absorbed dose to water primary standard follows a series of steps. Firstly, a transfer instrument is calibrated against the free-air primary standard at a reference distance from the X-ray machine. Ionization in a water phantom at the same location and using the same transfer instrument is then measured. The absorbed dose to water is determined using measurements of this type for a series of different transfer chambers and using Monte Carlo simulations of the entire process, including the X-ray source. This novel method has reduced measurement uncertainties in the clinic from 3 % to 0.7 %. This new system has allowed the BIPM to offer the NMIs a very accurate and stable primary standard for comparisons. The BIPM has improved the service it offers in the area of comparing primary standards in high-energy photon fields through the signing of a collaborative agreement with CEA-LIST for access to the DOSEO facility at Saclay. This agreement has allowed the department to set up a new service for comparing high-energy photon standards. Beam characterization and instrument validation at this linear accelerator has been completed and the first comparison exercise with KRISS will start during October 2017.

In radionuclide metrology, the department's main comparator is the SIR, which sets the KCRV for 68 long-lived gamma-emitting radionuclides. The ^{60}Co SIR result from the NRC (Canada), using its new radionuclide metrology laboratory, was published during 2017. Comparisons were carried out in 2017 using the SIR for ^{60}Co (PTB), ^{231}Pa (NPL), ^{113}Sn (LNHB), ^{54}Mn (PTB), ^{131}I (NMISA) and ^{166m}Ho (NMISA). The BIPM worked with the NPL during 2017 to develop a new protocol so that the SIR can be applied to radionuclides with complex decay series. Dr Judge commented that the Ionizing Radiation Department is investigating how to set up comparators for beta-emitting and alpha-emitting radionuclides and ultimately how it can support environmental measurements for areas such as nuclear decommissioning. He remarked that these are expanding areas.

Dr Judge recalled that a robust transfer instrument for comparisons (SIRTI) of short-lived radionuclides was developed in 2009. The SIRTI will be used for a comparison exercise at ANSTO (Australia) starting in November 2017 and comparisons of ^{99m}Tc, ^{18}F and ^{64}Cu were carried out at POLATOM (Poland) in October 2016. In addition, a first comparison exercise for ^{11}C, which is used for positron emission tomography, was undertaken at the NRC (Canada). A study has started on setting up a similar comparator system to the SIR for beta-emitting radionuclides (extended SIR). This represents a difficult technical challenge and two secondees from NIM and NIST have completed an initial study, which included eight NMIs, four radionuclides and two possible techniques. No consensus has been reached on the best technique to use and work will continue in 2018.

He summarized some of the future work to be undertaken by the Ionizing Radiation Department. Its aim is to enable NMIs and DIs to demonstrate equivalence of primary standards, both easily and at an accuracy that is fit for purpose. The use of the DOSEO facility will be consolidated and new technologies will be used to maintain the international reference standards. The SIR will be extended to beta emitters and ultimately to alpha emitters and low-activity standards. Opportunities for secondments, co-operation and collaborative research will be increased and the department will work with the CCRI to simplify the process used to demonstrate equivalence.

Dr Judge finished his presentation by saying that 7 November 2017 marks the 150th anniversary of the birth of Marie Curie: he gave a brief summary of her life, achievements and links to the BIPM. He thanked his colleagues in the Ionizing Radiation Department and acknowledged the work of Mr Los Arcos and Dr Ratel, both of whom had recently retired.

The President thanked Dr Judge and asked for any questions and comments. He was asked to clarify where the IAEA/WHO Secondary Standards Dosimetry Laboratories (SSDLs) fit into the traceability chain. It was confirmed that the IAEA as well as certain organizations in the IAEA network send chambers to the BIPM for calibration. There are five collaborating organizations associated with the IAEA network, of which the BIPM is one. There are also 15 affiliated laboratories with primary standards that offer calibration services to the IAEA laboratories. The BIPM acts as the central point for all the primary standards for the NMIs and the IAEA laboratories can choose to come to the BIPM for calibrations or to go to the IAEA or the NMIs. The SSDL network, underpinned by the IAEA and traceable to the BIPM, is very important for supporting traceability for dosimetry for radiotherapy, diagnostic imaging and radiation protection for IAEA member states. Without this network, the amount of extra work for the BIPM would be significant. Dr Judge was asked if there is a clear work plan for extending the SIR to beta emitters, considering the amount of work that has already been carried out. He replied that various techniques have been tried. The first technique involved using a commercial liquid scintillation counter; however the initial studies had not provided conclusive evidence that such counters could be used as comparators. Other technologies will be investigated such as plastic scintillation beads or plastic scintillators. It was asked how the BIPM contributed to the reduction in measurement uncertainties from 3 % to 0.7 % in the clinic for new absorbed dose to water primary standards. Dr Judge answered that the BIPM worked on the method and developed the Monte Carlo simulations.

Dr Milton remarked that the Ionizing Radiation Department has undergone significant changes over the last year, with the change of Director from Mr Los Arcos to Dr Judge, and the start-up of the DOSEO collaborative project. He acknowledged the work of the former Director of the department, Mr Los Arcos in negotiating the agreement with CEA-LIST for access to the DOSEO facility at Saclay. Dr Milton noted that there are other sources and accelerators at Saclay, which could form the basis for future strategic plans in the department. Dr Judge was asked to comment on who was responsible for ensuring that the accelerator at Saclay was characterized to a level where it can be used for calibrations. He replied that stability checks and characterization of the beams have been carried out by staff from the Ionizing Radiation Department. The accelerator itself is operated by staff at Saclay and the collaborative agreement gives the BIPM access for a certain number of weeks per year. Dr Picard added that the BIPM has around ten years' experience of working with high-energy radiation beams around the world. Dr Judge commented that the Saclay facility is situated close to the BIPM, which significantly reduces the need for BIPM staff to travel in order to carry out reference measurements and comparisons. In addition, working with a well characterized beam does not require work to be repeated when travelling to NMIs, leading to improvements in efficiency for the service provided. At present, the work can be covered by the existing team, without the need for recruitments. Dr Usuda, President of the CCAUV, recalled that a representative from the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) had been invited to their last meeting in September 2017. He commented that they have an interest in the activities of the Ionizing Radiation Department and asked if there are any plans to collaborate with the organization. Dr Judge replied that he has been in touch with the CTBTO and will meet with them. He added that the CTBTO already takes traceability for the measurement of radioactivity collected on air filters from the BIPM, through the NMIs.

Consultative Committee for Ionizing Radiation (CCRI)

Dr Louw said that the CCRI meetings held in June 2017 had been the first under its reorganized structure. He gave an overview of the new structure and commented that the duration of the meetings had been reduced

from 21 days previously to 9 in 2017. The CCRI now has eight members, 14 official observers and four liaisons: the European Commission - Joint Research Centre (JRC); the International Atomic Energy Agency (IAEA); the International Commission on Radiation Units and Measurements (ICRU); and the International Committee for Radionuclide Metrology (ICRM). The meetings had included discussions on the CCRI strategy, including the "grand challenges" facing ionizing radiation. The grand challenges mentioned were external beam radiotherapy, radio-immunotherapy, nuclear decommissioning, next-generation nuclear power, nuclear forensics and radiation protection. The CCRI's strategy discussions had included the CIPM MRA review and the roles and responsibilities of the BIPM, the NMIs and the IAEA.

Dr Louw recalled that the CCRI had discussed the regulations concerning the use of high-activity sealed sources, which have become increasingly stringent and that significant work may be needed to ensure compliance with local regulations. This particularly affects the SIR system, which depends on two ionization chambers and sealed ^{226}Ra sources. He commented that discussions are under way with the *Autorité de sûreté nucléaire* (ASN) regarding the issue.

Progress in CCRI Section I (x- and gamma rays, charged particles) since the last meeting of the CIPM has included the commencement of work on high-energy photon fields through the signing of a collaborative agreement with CEA-LIST for access to the DOSEO facility at Saclay, and discussions on what should be done to prepare for traceability for hadron therapy. The CCRI Section I strategy has looked at the future of ^{60}Co sources at the BIPM. One of the ^{60}Co sources at the BIPM will need to be replaced in about 5 years. It was noted that although many hospital irradiation units are being replaced by LINACs, there are still a significant number of ^{60}Co sources in use world-wide and that NMIs maintain ^{60}Co as their most stable reference. Discussions as to whether to replace the ^{60}Co source, or if alternative ways to provide this service should be sought are under way. One other ^{60}Co source will not be replaced in 2018, leading to a saving of around 200 k€.

In CCRI Section II (measurement of radionuclides) the future strategy includes extension of the SIR to cover alpha and beta-emitters, which has a strong justification (underpinning applications in nuclear medicine, the nuclear industry and nuclear forensics via the NMIs). The possibility of establishing a new independent SIR system for gamma-emitters is being investigated. This would reduce the long-term risk of breakdown and would avoid the need for maintaining high-activity ^{226}Ra sources. The CCRI Section II strategy will also investigate the need for comparisons in airborne radioactivity or additional comparisons in large area reference sources, whether the BIPM should have a capability for realizing some primary radioactivity standards, and if there is a requirement to establish a clear scheme for traceability for radioactivity in matrices (building materials, metals, soils, etc.) in the area of nuclear decommissioning.

Dr Louw said that in CCRI Section III (neutron measurements), discussions are under way on what will be needed to underpin neutron metrology for next generation nuclear power reactors, including the International Thermonuclear Experimental Reactor (ITER) and the infrastructure that will be needed for high-energy neutron dosimetry for radiation protection around accelerators.

He summarized the outcomes of the CIPM MRA review by the CCRI and commented that the three CCRI sections are reviewing service categories and that input on the templates for KCDB 2.0 will be provided by January 2018. CCRI governance issues had been discussed at the meeting in June 2017, particularly the methodology and procedure for membership and observership, and its correct application. Dr Louw concluded by summarizing the work of the CCRI Strategy Working Group, which included a review of the needs of NMIs, DIs and the ionizing radiation user community, the role of the BIPM's ionizing radiation programme internationally, and capacity building and knowledge transfer opportunities for secondments within the department. The President thanked Dr Louw and invited questions and comments. Dr Louw was complimented on the significant progress that has been made within the CCRI over the last few years.

Dr Fang, Dr Robertsson and Dr Viallon left the meeting.

Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV)

Dr Usuda said that the most recent meeting of the CCAUV had been held in September 2017, with 51 participants at the Working Group, Workshop and plenary sessions. He commented that the CCAUV has 18 members, 12 observers and two liaisons: the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

The CCAUV strategic plan for 2017 to 2027 and its summary have been published on the website. The highlights of the strategic plan include applications in: environmental monitoring; medical and diagnostics; occupational safety; engineering and production. The strategic plan also includes emerging applications for MEMS sensors and the importance of relationships with other international organizations such as ISO, IEC, and the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO). The CTBTO is particularly interested in regular dialogue with the CCAUV concerning infrasound and low-frequency vibration traceability for its International Monitoring System (IMS). He added that there is currently no significant work in progress for reviewing current CMCs in the CCAUV area but it plans to pursue a risk-based assessment approach towards reviewing CMCs in the future. The planning process for key comparisons involves careful consideration in order to optimize the resource requirements needed to respond to the needs of its stakeholders. Some mature key comparisons have reached the stage where repeats, which are normally conducted on a 10-year cycle, are being carried out to assess them as well as to extend their calibration range.

Dr Usuda summarized the implications of the review of the CIPM MRA for the CCAUV. He finished his presentation by informing the CIPM of the CCAUV's opinion on the revision of the SI and 9th SI Brochure. The future revision of the SI does not have an immediate impact on acoustic, ultrasound and vibration metrology; however it will underpin future requirements for increases in accuracy. A coherent metric system among the mechanical and electro-magnetic quantities is indispensable for improving MEMS sensor calibrations. With these considerations, the CCAUV strongly welcomes the future revision of the SI and the agreed timetable. He remarked that the logarithmic scales the 'neper' and the 'bel' had been used in a specific technical area. The CCAUV welcomes the draft 9th edition of the SI Brochure, which includes these non-SI units, as accepted for use with the SI Units in Table 8 of the brochure. He added that it is advisable that the conventional value of g_n (standard acceleration due to gravity) associated with the declaration at the 3rd CGPM (1901) be mentioned in Appendix 1.

The President thanked Dr Usuda and asked for comments. He was asked to comment if there has been any growth in the number of NMIs that are involved in acoustics, particularly underwater acoustics: historically, the number had been relatively small and the CCAUV had formed links with the defence community. Dr Usuda said that although growth has been slow there are now 18 members of the CCAUV. Recent interest has been expressed from developing NMIs and the Gulf region; in the recent roadmap presented by SASO (Saudi Arabia) during the CCAUV meeting it was shown they plan to become a member. The Director said that neper and bel will be included in Table 8 of the 9th edition of the SI Brochure and g_n in Appendix 1.

Consultative Committee for Thermometry (CCT)

Dr Duan reported that the CCT had held its most recent meeting in June 2017. He said that a significant part of the meeting had been taken up with discussions on the redefinition of the kelvin, including information on the techniques that have been employed for the determination of the Boltzmann constant and the available data. He gave an update on the future redefinition of the kelvin including the input data for the CODATA Special

Adjustment 2017. The criteria set in CCT Recommendation 2014 "On a new definition of the kelvin", particularly that the relative standard uncertainty of the adjusted value of k is less than 1×10^{-6} and that the determination of k is based on at least two fundamentally different methods, of which at least one result for each shall have a relative standard uncertainty less than 3×10^{-6}, have both been fulfilled. The *mise en pratique* for the realization of the kelvin has been submitted to the CCU and the appendices are being drafted, with a completion date of December 2017. The CCT has drafted Recommendation T1 (2017) "For a new definition of the kelvin in 2018", which recommends that the CIPM finalizes the unit redefinitions by agreeing to fix the values of the fundamental physical constants, from which a fixed numerical value of the Boltzmann constant with eight digits will be adopted for the redefinition of the kelvin; and that Member State NMIs take full advantage of the opportunities for the realization and dissemination of thermodynamic temperature afforded by the kelvin redefinition and the *mise en pratique* for the definition of the kelvin.

Dr Duan commented that in the short term, the impacts of the redefinition of the kelvin will include the definition being independent of any material and there will be no favoured fixed point or measurement method. In addition there will be no error propagation from the triple point of water (TPW), and thermodynamic measurements and the ITS-90 will coexist. In the longer term, improvements of primary thermometry thermodynamic measurements may replace the ITS-90. The CCT Task Group for the SI (CCT TG-SI) and the CCT Task Group for the Realization of the Kelvin (CCT TG-K) have been closed as both groups have completed the tasks within their remit.

The Task Group for Sealed Metal Freezing-Point Cells (TG-SMFPC) has fulfilled its mission and has been closed. A new Task Group on Emerging Technologies has been formed under the auspices of the CCT Working Group for Contact Thermometry (CCT WG-CTh), which will have six focus areas. In the area of primary thermometry it will focus on optomechanical thermometry, optical thermometry, nanoelectronics-based thermometry and quantum conductance. In the area of ITS-90 traceable thermometry it will focus on optical thermometry resonators and photonic thermometry. The Task Group on Emerging Technologies has a responsibility to survey new technologies that may be of use to the whole thermometry community in terms of future primary realizations of the kelvin.

Dr Duan concluded by commenting that the CCT has launched an update of its strategy and recommends that the CCT Task Group for Environment (CCT TG-Env) should become a Working Group. This is in recognition of its growing collaborative role with the World Meteorological Organization (WMO): in 2019 there will be a joint conference between the thermometry and meteorological communities in the area of temperature monitoring. The President thanked Dr Duan for his presentation.

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

BIPM Time Department

Dr Arias presented the activities of the BIPM Time Department since October 2016. A major theme has been to improve the uncertainty of UTC-UTC(k). This has been achieved through enhancements to the statistical uncertainty of time transfer, improved knowledge of calibrations through the programme with the RMOs and improvement of the algorithms.

Progress with the seven time metrology projects in the BIPM Work Programme for 2016-2019 was described. The Time Department has hosted three visitors and secondees since the last meeting of the CIPM: Dr Demetrios Matsakis (USNO) worked on algorithms in November 2016; Dr Liang Kun (NIM) is working on BeiDou time transfer techniques, which are described below, as part of a Memorandum of Understanding (MoU) between the BIPM and NIM from February 2017 to February 2018; and Dr Julia Leute (formerly PTB) is working as a post-Doc on advanced time transfer from August 2017 to August 2019.

Dr Arias described the first time transfer experiments using BeiDou satellites over multiple baselines. These pilot experiments are being carried out under a cooperative agreement between the BIPM and the NIM (China) to validate the use of BeiDou time transfer in the regular computation of UTC. The time comparisons have involved the BIPM and institutes (LNE-SYRTE, CNES, PTB, NIST, VNIIFTRI, TL and NIM) that are well distributed across the metrology regions. The absolute calibration of a BeiDou receiver will be carried out at the CNES under an agreement that has already been developed with the BIPM; this represents the first time that this calibration chain has had an impact on the time community. The knowledge gained from the pilot experiments will be used to develop calibration capacities at the BIPM and NIM. The pilot work is also an important first step towards implementing multi-system time comparisons in UTC. A 30-day GPS-BeiDou comparison over the NIM-BIPM baseline has found that time differences computed with BeiDou are consistent with those from GPS.

The department has continued to work on improvements to the uncertainty of time transfer through its work on TWSTFT: it is a very stable and accurate technique but with a problem emanating from the presence of diurnal noise. A reduction of diurnal noise in UTC time comparisons can be achieved through the use of software defined radio receiver modems (SDR) in TW stations. A pilot study was launched in 2016 with the participation of TL, NICT, KRISS, NTSC, NIM, PTB, LNE-SYRTE, VNIIFTRI, INRIM, METAS, AOS, RISE and NIST to test the SDR technique. The SDRs were proven to significantly reduce the noise of time transfer over short distances, but less so over long distances. Most TW stations have implemented the technique and the next step is the implementation of the SDR in time transfer for UTC computation. Further work on this technique will be carried out in cooperation with the LNE-SYRTE.

Improvements in the uncertainty of UTC-UTC(k) will require changes to the underlying algorithm. The current values of uA and uB, as published in *Circular T*, strongly depend on the time link uncertainties. All the time links connect each contributing laboratory to the PTB and the uncertainty of PTB is underestimated. No correlations are taken into account in the current uncertainty propagation algorithm. A new algorithm for the calculation of the uncertainties of [UTC-UTC(k)] has been developed to correctly take correlations in the uncertainty propagation into account. The algorithm was validated by the CCTF in June 2017 and is scheduled for implementation in November 2017. The new algorithm will include two major changes: the pivot for GNSS time links will be an auxiliary time scale instead of the PTB and the correlations have been added.

Dr Arias presented progress with GNSS equipment calibrations for improving the accuracy of [UTC-UTC(k)] by implementing continuous calibration campaigns to reduce time link uncertainty from 5 ns to 1.5-2.5 ns. The system was established in 2014 involving G1 laboratories in the RMOs that provide calibrations within their region. The BIPM calibrated all the G1 (node) laboratories at the outset and the second calibration tour is now under way, as per the agreement to recalibrate every two years. The system is working well.

An update of the regular services provided by the Time Department was presented. In terms of UTC, there are now 80 participants in monthly *Circular T* and 59 participants in the key comparison CCTF-K001.UTC. The discrepancy results from institutes that have not signed the CIPM MRA being unable to participate in the key comparison. It is expected that in 2018 a minimum of 90 institutes will participate in UTC. Rapid UTC (UTCr) had 52 participants as of October 2017. The algorithm used to calculate UTCr was improved in mid-2017 by correcting an inconsistency in the model of weighting of clocks in UTCr and UTC. UTCr is performing well and is reproducing UTC to within about 3 ns.

The department is taking part in the BIPM CBKT programme by organizing a training course on “Effective participation in UTC”, which is scheduled to take place in February 2018. Fifteen institutes will participate and the course will be open to RMO technical chairpersons in time and frequency. The course will be sponsored by METAS and it will include lecturers from METAS, the PTB and GNSS equipment developers. The aim of the course is to transfer knowledge on how to work effectively with receivers and equipment during a calibration campaign.

Dr Arias spoke about the celebrations for the 50th anniversary of the adoption of the atomic definition of the second by the 13th CGPM on 13 October 1967. The CCTF celebrated the event by inviting Dr Dennis McCarthy (USNO, IAU) to give a lecture at its meeting in June 2017. In addition, a *Journée Scientifique* "*La seconde atomique a cinquante ans*" was held at the Paris Observatory on 13 October 2017. Dr Arias and Dr Petit were co-organizers and lecturers at the event.

Dr Arias concluded her presentation by mentioning staffing in the Time Department and commented that she will retire on 30 November 2017. Dr Jiang will retire in mid-2018 and Dr Robertsson at the end of 2018. These retirements could leave the BIPM without expertise in TWSTFT and optical metrology. Following the retirement of Dr Lewandowski in mid-2014, there has already been some interruption in GLONASS research. She warned that this loss of expertise needs to be addressed to maintain the BIPM's presence in key areas, such as the redefinition of the second, as well as addressing the potential increase in the workload for the current physicists. The President thanked Dr Arias and invited questions.

The current status of gravimetry comparisons was questioned, particularly the BIPM's involvement following the CIPM's decision to discontinue the activity. Dr Arias commented that the BIPM still provides support. The BIPM is consulted when the technical protocols for gravimetry comparisons are prepared and the BIPM has been asked to audit the facilities that participate. It was noted that this support may no longer be possible following the retirement of Dr Jiang. Dr Arias was asked to elaborate on how the BIPM can ensure that it maintains a presence in the work towards the redefinition of the second. She remarked that the BIPM's main involvement is via time and frequency transfer. The NMIs have done excellent work in developing optical standards and the BIPM needs to maintain its involvement in comparing these standards. The BIPM must ensure that it does not lose, and indeed develops, its expertise in optical fibre transfers as well as developing other methods. The department has worked closely with the CCTF Working Group on Coordination of the Development of Advanced Time and Frequency Transfer Techniques (WGATFT) to ensure that it continues its involvement, particularly where geodetic and optical metrology are involved. The Director recalled that there will be a number of recruitments, including the new Director of the Time Department and a new physicist in 2018. He noted that expertise in optical frequency standards will possibly be included in the job specification for the new physicist.

Consultative Committee for Time and Frequency (CCTF)

Mr Érard gave an overview of the membership of the CCTF and said that its 21st meeting, held on 8-9 June 2017, had been attended by 48 representatives from its member institutes, as well as four representatives from its official observers and four from its liaisons. The NMIs gave an update on their activities at the meeting. They indicated that fountain standards, both single and double, are still being developed to give further improvements in their uncertainties and that there are four Cs fountains in almost continuous operation. Significant developments with optical clocks are ongoing, with Yb and Sr lattices and Yb^+ and Sr^+ single ions being the most studied, and Hg^+ and Al^+, which are presently the most accurate. The NMIs reported that some optical fibre links (Europe and Asia) are operational for frequency and time comparisons while others are under development. The PTB is working on a transportable optical clock.

The CCTF Working Group on Primary and Secondary Frequency Standards (WGPSFS) reported at its meeting that 11 primary frequency standards (Cs) and one secondary representation of the second (Rb) report regularly to TAI and that one secondary representation of the second, (^{87}Sr from LNE-SYRTE) was accepted for publication in *Circular T*. The CCL-CCTF Frequency Standards Working Group (CCL-CCTF-WGFS) had met and approved three new software applications for processing data for the clocks that report to the WGFS. It also reported the results of the evaluation of the recommended frequencies and related uncertainties of the 14 optical clocks that are compared to ^{133}Cs. Six clocks required no update and eight were updated. ^{199}Hg has been recommended as a new secondary representation of the second (SRS). Mr Érard said that previously, the list of recommended frequencies for SRS had been submitted to the CIPM for approval. It is proposed that in

the future, the new frequencies that have been analysed by the CCL-CCTF-WGFS and agreed within the CCTF and CCL, should be approved by the relevant CCs and then simply submitted to the CIPM for information. This would allow the CCTF and CCL to modify the list without having to wait for CIPM approval, recognizing that the frequencies have been analysed by the experts within the CCs. Dr Arias added that a paper has been submitted to *Metrologia* explaining how the list of frequencies is developed and computed.

The CCTF Working Group on TAI (WGTAI) has developed a recommendation that gives a formal definition of TAI and UTC. It has requested that these definitions should be presented to the 26th CGPM as a Draft Resolution for approval. This is related to the need to have formal definitions of TAI and UTC approved by the CGPM, which will help to clarify the role of the international metrology system in the definition of the reference time scale, and will be a contribution to the ITU World Radiocommunication Conference 2023 (WRC-23).

The CCTF Working Group on Two-Way Satellite Time and Frequency Transfer (WGTWSTFT) discussed studies on the long-term instability of UTC time links, the improvement of the statistical uncertainty using Software Defined Ratio (SDR) receivers for TWSTFT (daily diurnal variation) and the improvement of UTC time links and carrier phase TWSTFT. It also discussed development of digital TWSTFT modems for pseudo random noise (PRN) coded and carrier-phase TWSTFT, the calibration campaigns of TW Earth stations and an update of the guidelines.

The CCTF Working Group on GNSS Time Transfer (WGGNSS) has issued a new version of the BIPM guidelines for GNSS calibration and a new format for transferring data from GPS, Galileo, BeiDou and GLONASS has been developed. Studies to improve the uncertainty associated with the Precise Point Positioning technique with integer ambiguity resolution (IPPP) are ongoing. The meeting of the CCTF Working Group on Coordination of the Development of Advanced Time and Frequency Transfer Techniques (WGATFT) reported on the development of a transportable optical clock at the PTB and it received a progress report on the Atomic Clock Ensemble in Space (ACES) project. An update was given on the development of optical fibre links. New techniques are required that would allow the comparison of clocks between continents.

The CCTF Working Group on the CIPM MRA (WGMRA) has developed two new guidelines “Contribution of time laboratories to UTC” and “CCTF criteria for obtaining traceability in time and frequency” and a new document “Time and Frequency Supplementary Guide for Appendix B and C of CIPM MRA”. The CCTF Working Group on Strategic Planning (WGSP) has updated the CCTF Strategy document and the Roadmap to the redefinition of the second is being updated.

Mr Érard presented four CCTF Recommendations for noting and one (CCTF 3 (2017): Recommendation on the definition of time-scales), which is proposed for presentation to the 26th CGPM as a Draft Resolution. This will be discussed later in the agenda in §20.

He completed his presentation by noting that Dr Arias is retiring as the Director of the Time Department and that Dr Tavella will become the new Director in November 2017. The President thanked Mr Érard and invited questions and comments.

The proliferation of ‘chip-scale atomic clocks’ was raised and the question of who is responsible for assessing their traceability. This is important considering that they are finding increasing uses in industry and commerce. It was suggested that this is a topic for the future.

Consultative Committee for Length (CCL)

Dr Castelazo said that there had not been a meeting of the CCL since the last meeting of the CIPM. The CCL-CCTF Frequency Standards Working Group (CCL-CCTF-WGFS) had however met on 3-4 May and 6 June 2017. The CCL Working Group on the CIPM MRA (CCL-WG-MRA) will meet in Finland on

19-20 October 2017. He reviewed the membership of the CCL and noted that it has a total of 1608 CMCs registered in the KCDB. He further noted that the next round of the comparisons will combine long and short gauge blocks into one comparison.

The CCL Working Group on Dimensional Nanometrology (CCL-WG-N) has drafted a document 'Realization of the SI metre using silicon lattice and TEM for dimensional nanometrology'. The rationale for producing the document was that realizing the SI metre via the Si lattice may be more accurate and easier for dimensional nanometrology than using optical fringe sub-divisions. The document gives guidelines for the use of transmission electron microscopy (TEM) and the reference value of the bulk silicon lattice constant as a pathway for traceability to the SI metre for applications in dimensional nanometrology. Two additional documents are being prepared within the CCL WG-N as additional proposals for metre realizations that are more applicable to the needs of the nanometrology community.

He said that concerns have been expressed regarding availability of stable gas lasers. In industry, the majority of lasers used in dimensional metrology are He-Ne gas lasers; traceability is through iodine stabilized He-Ne lasers, typically at 633 nm. Discussions within CCL Discussion Group 11 (lasers) and at a recent CCL meeting highlighted the increasing lack of availability of specialist He-Ne tubes (for iodine laser preparation) and of new iodine cells. Industry's push for better accuracy and over longer lengths, together with the need for shorter calibration chains may require development of new stabilized diode lasers for *in situ* metre realization but at powers available for long/multiple path interferometry. This issue will be raised at the next CCL meeting.

Dr Castelazo concluded by saying that the CCL is re-examining CIPM Recommendation 1 (CI-1983) to determine whether it requires an amendment to make it clearer that the metre can be realized in two different ways (time of flight and interferometry) but with a secondary representation of the metre such as the lattice parameter of Si. The President thanked Dr Castelazo and invited questions and comments.

Dr Castelazo was asked to comment on the status of revising the CCL strategy, as the latest version on the website is from 2015. He replied that it will be discussed at the next CCL meeting in June 2018. Dr Robertsson added that a condensed version of the strategy was produced in 2016.

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

BIPM Physical Metrology Department

Dr Stock summarized the staff changes in the department since the last meeting of the CIPM. A new physicist will be recruited into the impedance metrology team to replace Mr Fletcher, who resigned on 31 August 2017. A second recruitment will be made for a person to work on the ensemble of reference mass standards (ERMS), to assist with mass calibrations following the transfer of Mr Idrees to the Chemistry Department and to cover for a staff member on long-term sick leave. There are currently two secondees working in the department: Dr Norihiko Sakamoto, a secondee from NMIJ who is working in the impedance area from 1 October 2017 to 30 September 2018; and Dr Mun-Seog Kim, a secondee from KRISS, who is working in the voltage area from 1 October 2017 to 30 September 2018.

The comparison programme in electricity, since the last meeting of the CIPM, has included an onsite comparison of quantum Hall resistance standards (BIPM.EM-K12) with CMI (Czech Republic), a bilateral comparison of Zener voltage standards (BIPM.EM-K11) with NMISA (South Africa) and a bilateral comparison of resistance (BIPM.EM-K13) with NMISA. In addition the CCEM comparison of capacitance (CCEM-K4) with the BIPM as the pilot is under way. The participants are METAS (Switzerland), NIM (China), NIST (USA), NMIA (Australia), NPL (UK), PTB (Germany) and VNIIM (Russia). This is the first time a CCEM comparison has been organized using the 'star scheme'. This scheme will allow the comparison to be completed much faster and it is also more robust against potential transport problems: if a

standard fails it is only one participant that will sustain problems rather than all the participants in the loop. The Draft A report is expected by the end of 2017. Further onsite comparisons of quantum Hall resistance standards (BIPM.EM-K12) are being planned for 2018 at A-STAR and the NMIJ. Another ten NMIs have expressed an interest in participating.

The BIPM is a member of the support group and a participant in GULFMET.BIPM.EM-K11, a key comparison of Zener voltage standards. The coordinator, Dr Steven Yang, SCL (Hong Kong (China)) received training at the BIPM during a two-month secondment. The department's involvement in this project formed part of its commitment to the BIPM CBKT programme. A pilot comparison of ac Josephson systems with the PTB has been carried out; the BIPM's 18 GHz programmable Josephson Voltage Standard (PJVS) is based on NIST technology. The results were encouraging with an uncertainty of better than 1 ppm. The uncertainty was limited by the ac source, so a dedicated ac signal generator needs to be developed. There have been challenges related to interference and ground loops, which need to be investigated. The evolution of the number of calibrations in voltage, resistance and capacitance from 2000 to 2016 was presented.

The provision of 1 kg Pt-Ir prototypes for the Member States is ongoing. Since the last meeting of the CIPM prototype No. 110 was delivered to NIM (China) in December 2016, No. 111 was delivered to KRISS (Republic of Korea) in July 2017 and No. 107, which is still at the BIPM, has been recalibrated for NPSL (Pakistan). Prototype No. 112 is under fabrication but not yet allocated; this will allow rapid delivery to fulfil the next order. Three Pt-Ir prototypes have been calibrated since the last meeting of the CIPM for KRISS, UME (Turkey) and NPSL, as well as three stainless steel prototypes for LATU (Uruguay), KIM-LIPI (Indonesia) and EIM (Greece). The BIPM is participating in the key comparison of 1 kg stainless steel mass calibrations, EURAMET.M.M-K4, to link it to a CCM comparison previously organized by the BIPM.

Dr Stock continued by giving an update on the CCM Pilot Study for a comparison of future realizations of the kilogram. The objectives were to test the consistency of independent realizations of the kilogram and continuity with the present definition, the IPK. Measurements were completed in November 2016 and the Draft A report was published in December 2016. The final report was available in June 2017 and a paper has been submitted to *Metrologia* for the focus edition on the redefinition of the kilogram. The calibration of 1 kg mass standards under vacuum with the future realization experiments at the LNE, NIST, NMIJ, NRC and PTB gave good results up to the end of 2016, with four results agreeing within the standard uncertainty and one agreeing within the expanded uncertainty described in §10. The weighted mean of the five results gave an uncertainty of only 10 μg and agreed well with the calibration by the BIPM based on the IPK. New results published in 2017 ready for the CODATA special fundamental constants adjustment found discrepancies of up to 70 μg that were dealt with as described in §10 by applying an expansion factor of 1.7 to the uncertainties. The CCM discussed the issue and agreed CCM recommendation G1 (2017), which gives information on how to proceed with consistent dissemination of the kilogram using the consensus value.

A schematic showing the multiple traceability paths (Kibble balances and Si spheres) for the kilogram after the redefinition was presented. Dr Stock noted that NMIs that have not developed a primary realization method will still be able to obtain calibrations from the BIPM or an NMI that has a primary method. The ERMS, which is has been operational since early 2017, will be central to the new dissemination scheme. The ERMS will be the reference for future key comparisons of the kilogram and will allow linking of bilateral comparisons to larger CCM comparisons. A paper describing the future maintenance and dissemination of the kilogram following its redefinition has been published in the *Metrologia* focus issue on the redefinition of the kilogram[5].

Dr Stock completed his presentation by giving an update on the status of the Kibble balance. Since the last meeting of the CIPM, a new mechanical set-up has been implemented giving a more stable suspension with additional adjustment mounts to facilitate coil alignment. The new stiffer mass loading and exchange system

[5] Stock M., Davidson S., Fang H., Milton M., de Mirandés E., Richard P., Sutton C., Maintaining and disseminating the kilogram following its redefinition, *Metrologia*, 2017, **54**, S99-S107.

allows the use of 1 kg mass standards, rather than 100 g. Alignment has been improved and there has been a reduction in the noise on force measurement. Two PJVS systems have been completed and the Kibble balance is now fully operational in both air and vacuum. Two papers have been submitted to *Metrologia* "Coil-current effect in Kibble balances: analysis, measurement, and optimization"[6] and "Self-attraction mapping and an update on local gravitational acceleration measurement in BIPM Kibble balance"[7], which describe some important aspects of this work. The first paper includes important correction factors that may be of use to other Kibble balance groups. The day-to-day repeatability of the measurements currently stands at several parts in 10^7 and an uncertainty of ~ 1×10^{-7} is expected by the end of 2017. The goal is $\approx 3 \times 10^{-8}$ by the end of 2019. The President thanked Dr Stock and invited questions.

Dr Stock was asked why the BIPM's Kibble balance results were not published before the CODATA deadline of 1 July 2017 considering that an uncertainty of 1×10^{-7} is expected by the end of 2017. He answered that a full uncertainty budget was not available before the deadline and the BIPM did not want to publish a value until there was complete certainty. It was suggested that a paper should be published to publicize the enormous efforts at the BIPM that have gone into the redefinitions to as wide an audience as possible. Dr Stock commented that the work is being well publicized and the Director recalled that a Communications Officer has been recruited to disseminate the message to the wider community.

Dr Arias, Dr Judge, Dr Panfilo, Dr Picard and Dr Robertsson left the meeting and Ms Guliyeva re-joined.

Consultative Committee for Electricity and Magnetism (CCEM)

Dr Rietveld recalled that the CCEM had held its 30th meeting in March 2017. This meeting devoted an afternoon session to the revised SI. The CCEM Working Group on Electrical Methods to Monitor the Stability of the Kilogram (WGKG) gave an update on progress with Kibble balances. The CCEM Working Group on Proposed Modification to the SI (WGSI) updated the CCEM on its progress. He noted that the final versions of the *mise en pratique* and the CCEM guidelines for implementation of the 'Revised SI' are close to being completed. The CODATA TG on fundamental constants reported on the special LSA to be carried out following the 1 July 2017 deadline. Prof. Ullrich presented a report to the CCEM on CCU activities on the preparations for the planned redefinitions. The CCEM had held a discussion on the 'var' with a proposal to the CCU to add 'var' in a side note to the 9th SI brochure. No formal recommendations concerning the revised SI were made at the meeting, however the CCEM considered that CCEM Recommendation E1 (2007) is still valid. The CCEM also held a one-day workshop on "Future challenges in electrical metrology" and the topics discussed were presented to the CIPM.

An outline of the CCEM guidelines for implementation of the 'Revised SI' was presented. Following the implementation of the revised SI there will be "step change" for electrical metrology. This change is addressed in the guidelines, which state that there will be a "small discontinuous change on the day of implementation of the revised SI". The document gives guidance to the electrical community on two questions: what do I need to do in preparation for the 'Revised SI' and what do I need to do on or immediately following implementation day (20 May 2019). Dr Rietveld asked the CIPM when the new *mise en pratique* and guidelines should be made publicly available.

He recalled the CCEM-K4 comparison described by Dr Stock in §15 and he praised the Physical Metrology Department for their work in piloting this comparison, particularly its use of the "star approach", which will strongly improve the efficiency of its performance. He highlighted the work undertaken by the BIPM electrical

[6] Li S., Bielsa F., Stock M., Kiss A., Fang H., Coil-current effect in Kibble balances: analysis, measurement, and optimization, *Metrologia,* 2018, **55**(1).

[7] Li S., Bielsa F., Kiss A., Fang H., Self-attraction mapping and an update on local gravitational acceleration measurement in BIPM Kibble balance, *Metrologia*, 2017, **54**(4) 445, doi:10.1088/1681-7575/aa71e1.

laboratories, commenting that there is considerable added value in the BIPM performing on-site comparisons of quantum standards for the world-wide EM community.

The CCEM Working Group on RMO Coordination (CCEM-WGRMO) meeting had focused on the review of the CIPM MRA and among other topics discussed the evaluation of the present "risk-based" approach of inter-RMO CMC review. The revision of CMC categories 8 and 9 had been discussed. It was agreed that for the whole of EM, the number of categories should not be reduced, as this would lead to more work than would be necessary to maintain the current situation. The CCEM Working Group on Low-Frequency Quantities (WGLF) and CCEM Working Group on Radiofrequency Quantities (GT-RF) had discussed the strategic planning of key comparisons: strategic planning in electrical metrology at the key comparison level is complete, but it acknowledged more work may be required at the RMO level. The CCEM has reviewed and updated its strategy: the summary document is available, and a more comprehensive version will be made available in the near future. The President thanked Dr Rietveld for his presentation.

Consultative Committee for Mass and Related Quantities (CCM)

Dr Richard said that he had presented the majority of his report in §10. He thanked Dr Fang, Dr Stock and Dr de Mirandés for their support over the last year.

The CCM had held its 16th meeting in May 2017, where it reviewed the situation with CCM Recommendation G1 (2013) and approved CCM Recommendation G1 (2017). It also approved the final results of the Pilot Study for a comparison of future realizations of the kilogram and noted that the BIPM ERMS is operational. Dr Richard commented that a focus edition of *Metrologia* on "Realization, Maintenance and Dissemination of the Kilogram" has been published. He noted that many of the papers in this focus edition are important references for the *mise en pratique* of the definition of the kilogram, the close-to-final version of which has been approved by the CCM. The CCM approved the statement to inform its stakeholders about the revised SI and the consequences for the mass community. The CCM strategy has been updated and will be published in October 2017. The next CCM meeting is planned for May 2019.

Dr Richard concluded by stating that traceability to a pooled value, called the consensus value, will ensure uniformity of the future definition of the kilogram, and that by carrying out the dissemination of the kilogram through use of the consensus value the CCM is ready for the redefinition in 2018. He noted that according to the replies to the recent CCU survey, a sufficient number of primary realizations will be available after the redefinition and that some NMIs are developing less expensive and more easily operated apparatus to realize the kilogram. Finally, he suggested that all the *mise en pratique* documents developed by the CCs should be harmonized, using a common layout and style sheet.

The President thanked Dr Richard and invited questions and comments. The Director supported the suggestion for a harmonized approach to the presentation of *mises en pratique* and proposed that this be a formal decision. This suggestion was supported by the CIPM.

Decision CIPM/106-15 The CIPM decided that the *mises en pratique* prepared by the CCs for each of the base units should be presented in a common format to be developed by the BIPM editing team.

Consultative Committee for Photometry and Radiometry (CCPR)

Dr Rastello began her presentation by thanking Dr Viallon, Executive Secretary of the CCPR, for her support during the transition period since she took over as President of the CCPR in January 2017. She gave a brief summary of its structure and membership and commented that the CCPR had not met since the last meeting of the CIPM, although the Working Groups had met in Tokyo during 10-12 June 2017. Dr Rastello announced three new chairpersons for the Working Groups. Maria E. Nadal-Laracuente, NIST (USA) will take over as

chair of the CCPR Working Group on Strategic Planning (WG-SP) in July 2018, Dong-Hoon Lee, KRISS (Republic of Korea) will become the new chair of the CCPR Working Group on Key Comparisons (WG-KC) also in July 2018, and Marek Šmíd, ČMI (Czech Republic) has been the chair of the CCPR Working Group on CMCs (WG-CMC) since January 2017. Dr Rastello remarked that the new chairpersons represent three different RMOs: SIM, APMP and EURAMET.

Dr Rastello recalled that the *mise en pratique* for the definition of the candela[8] had been published in *Metrologia* in May 2016. A new version of Appendix 3 on photochemical and photobiological quantities has been produced, which will be made available online in the 9th edition of the SI Brochure. The CCPR sent comments to the CCU on the 9th edition of the SI Brochure, which have been broadly accepted. The guidelines for the "Principles Governing Photometry" have been revised by the International Commission on Illumination (CIE) and are waiting for publication of the 9th SI Brochure. These guidelines will subsequently be published in the *Metrologia* section on "Guides, Standards and Conventions".

The CCPR has established three task groups within the WG-CMC: to examine use of comparison results in assessment of CMC claims, to update the Excel PR CMC supporting evidence file, and to clarify and harmonize the CMC review process. These studies will be completed by July 2018. Two invited speakers from the CCPR were invited to the 13th International Conference on New Developments and Applications in Optical Radiometry (NEWRAD 2017), which was held in Tokyo on 13-16 June 2017. The 24th meeting of the CCPR has been postponed until 2019, although meetings of the WGs will be held at the BIPM in July 2018.

The President thanked Dr Rastello and commented that she had agreed to take on the role of CCPR President before attending her first CIPM meeting. He asked if there were any questions or comments. The Director said that the *mise en pratique* had been the first document to be published in the new section of *Metrologia* called "Guides, Standards and Conventions". This section allows the publication of any documents that have been peer reviewed through a committee. The advantage is that such papers are then assigned a DOI, making them easier to reference and to search for electronically. Dr Rastello was asked to comment on the forthcoming redefinition of the candela rather than the lumen as a base unit. She said that this is something that can be worked on in the future, as changing from the candela to the lumen has many advantages, but the CIE is strongly opposed to having the lumen as a base unit. It was asked if there are any plans to hold a joint meeting between the CCPR and the CIE. Dr Rastello replied that this could be considered for 2019.

Dr Arias, Dr Fang, Dr Stock, Dr Viallon and Dr Wielgosz left the meeting.

16. REVISION OF THE RULES FOR PARTICIPATION IN THE CONSULTATIVE COMMITTEES

Engagement with international organizations as "liaison"

Mr Henson said that much of the analysis on the engagement of international organizations as "liaison" in the Consultative Committees (CCs) had been carried out by Ms Guliyeva. He commented that the BIPM has a range of liaisons with other organizations. These arrangements are periodically updated and such relationships work efficiently. Liaisons through the Joint Committees are clearly defined through the associated rules and terms of reference.

The situation involving liaisons in the CCs is less well defined. There are a total of 31 organizations that liaise with the CCs. In some cases, there are multiple sub-sets of the same organization that interact, for example in the case of the International Organization for Standardization (ISO), the BIPM works with both ISO CASCO and ISO REMCO: interaction with them is at both the institutional and technical level.

[8] Zwinkels J., Sperling A., Goodman T., Campos Acosta J., Ohno Y., Rastello M.L., Stock M., Woolliams E., *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), *Metrologia*, 2016, **53**(3), G1. http://dx.doi.org/10.1088/0026-1394/53/3/G1.

The BIPM's relationships with intergovernmental organizations and international non-governmental organizations are well understood and documented. However, the interaction with international scientific unions, sector-specific organizations, and regional organizations is less well defined.

In order to find a way forward, a study was carried out into the way that other organizations define and interact with their liaison organizations. As a result he proposed that 'liaison organizations' status be granted, based on the following criteria:

- the organization should be international in its structure and scope of activity[9] and representative of the specialized field of interest in which it operates
- the organization should be concerned with matters covering a part, or all, of the BIPM's fields of activity
- it should have aims and purposes in conformity with the Vision, Mission and Objectives of the BIPM
- it should have a permanent directing body and Secretariat, authorized representatives, and systematic procedures and machinery for communicating with its membership in various countries
- its members should exercise voting rights in relation to its policies or action or shall have other appropriate mechanisms to express their views
- the organization should have been established at least three years before it applies for liaison status.

Mr Henson remarked that not all organizations will fulfil these criteria. The interaction may be on a short term, one-off basis, with no requirement to develop a long-term relationship and a formal agreement. In such cases, organizations can be considered as having the status of "organizations in cooperation' and be dealt with on a case-by-case basis. He said that a decision had been drafted that proposes a structured way for engagement with international organizations as "liaisons" at the CCs.

The President thanked Mr Henson and commented that the views of the CIPM are sought, in particular as to how to ensure that representatives from the "liaisons" truly represent the views of their organization. Mr Henson was asked to clarify whether the BIPM can invite an organization to become a "liaison", rather than it approaching the BIPM. He confirmed that this could happen if there is a valid reason, or an organization can simply be approached as an "organization in cooperation" for a one-off topic-based interaction. He added that when the BIPM joins another organization as a "liaison" it is usually necessary to meet the criteria set by the organization. Prof. Ullrich commented that the CCU has organized its members into international unions, international commissions and committees and international bodies. He asked if the CCU should retain its classification and criteria for 'liaison organizations'. The Director replied that the CCU classification is informal but there is no need to change it as the type of member organizations that the CCU interacts with are included under the proposed criteria for 'liaison organizations'. Mr Henson added that the term 'liaison organizations' is generic and that in this context it is more important how an organization interacts with the CCs rather than how it is categorized. Dr Rietveld asked if the proposed criteria would solve the problem of whether or not a representative from a liaison organization will really represent the views of that organization, and be sufficiently knowledgeable in the topics covered by a specific CC. He qualified this question by commenting that he had been considering inviting the IEC to become a liaison organization of the CCEM. The Director answered that, for example, in the case of ISO, its attendance at Joint Committees is via a staff member that represents ISO policy at a high-level. For ISO working groups, the criteria and specific knowledge become more important to ensure that the representative brings a perspective from their particular technical committee and can contribute to the work of the CCs. Dr Louw commented that the CCRI's relationship with organizations such as the IAEA is clearly defined and the rules of the MoU and any such agreements should state that any representative should represent the views of his/her organization. It was

[9] International non-governmental organizations shall be considered "international in structure and scope of activity" if they have members and carry out activities in at least three countries.

suggested that the decision could include a provision that any representatives should be appointed far enough in advance to enable them to prepare before attending a CC meeting. This would ensure that they represent their organization and make a useful contribution. The text of the proposed decision was presented.

Decision CIPM/106-17 Following Decision CIPM/105-27 (on the engagement of international organizations as "liaisons" at the Consultative Committees), the CIPM decided that the status of liaison within the context of the Consultative Committees will be decided upon in each case by the CIPM.

The CIPM will base its decision on the extent to which the international organization concerned meets the following criteria:

- being international in structure and scope of activity, and representative of the specialized field of interest in which they operate;
- being concerned with matters covering a part, or all, of the field of activity of the BIPM;
- having aims and purposes in conformity with the Vision, Mission and Objectives of the BIPM;
- having a permanent directing body and secretariat, authorized representatives and systematic procedures and machinery for communicating with its membership in various countries;
- allowing its members to exercise voting rights in relation to its policies or action or having other appropriate mechanisms to express their views; and
- having been established at least three years before they apply for liaison status.

Organizations that are not offered liaison status within the context of the Consultative Committees will be known as "organizations in cooperation".

Document CIPM-D-01 will be updated accordingly.

Objectives of the CCs

The Director said that the objectives of the CCs had been discussed at the CC Presidents' meeting in June 2017 and that he had completed an action to propose changes to the text of document CIPM-D-01 "Rules of procedure for the Consultative Committees (CCs), CC working groups and CC workshops" to reflect the outcome of the discussions. This action required revised text to be presented to the CIPM for discussion and approval. Mr Henson read the revised text and recalled that this revision had been proposed to address the perceived problem that the CIPM MRA was beginning to dominate the work of the CCs. The revision brings the objectives of 'engaging with stakeholders' and 'providing a forum for the state-of-the-art' to the forefront of the work of the CCs now that the CIPM MRA is well established and operating efficiently.

There was a comprehensive discussion of the revised text and it was noted that some of the suggestions were covered by the section on "responsibilities" in document CIPM-D-01, rather than "objectives", which were under discussion. The Director commented that there are other elements of document CIPM-D-01 that will require an overhaul, and that revising the objectives was simply the first step. Other information in CIPM-D-01, such as the CCs giving advice to the CIPM on all scientific matters that influence metrology, will not be affected by the proposed revision and will remain unchanged.

Decision CIPM/106-16 The CIPM decided the following text for inclusion in CIPM-D-01:

In order to be informed of technical developments and evolving stakeholder needs in different areas of metrology, the CIPM has Consultative Committees with agreed scopes and the following three objectives:

- to progress the state-of-the art by providing a global forum for NMIs to exchange information about the state of the art and best practices,
- to define new possibilities for metrology to have impact on global measurement challenges by facilitating dialogue between the NMIs and new and established stakeholders, and
- to demonstrate and improve the global comparability of measurements. Particularly by working with the RMOs in the context of the CIPM MRA to:
    - plan, execute and monitor KCs, and to
    - support the process of CMC review.

Document CIPM-D-01 will be updated accordingly.

Prof. Ullrich returned to the issue of liaisons and recalled that the CCU had received letters from the Presidents of IUPAC and IUPAP stating that they were not content to have their status changed from member to liaison (See Decision CIPM/105-27 and CIPM/105-28). A discussion had been initiated during the CCU meeting by the IUPAP representative who suggested that the scientific unions should have a special role within the CCU with a specific membership criteria. Prof. Ullrich and Dr Milton had explained to the CCU during its meeting that the intention of introducing the category of liaison had been to improve the interaction between the CCU and the scientific unions. It was recalled that Decision CIPM/105-28 states that "the CCU will adopt the same criteria for participation as the other CCs for all meetings in 2018 and beyond." This is after the date of the proposed redefinitions, so the situation regarding any potential votes within the CCU on matters affecting the revised SI will not change. The scientific unions also expressed disquiet that they had not been consulted before the category of "liaisons" had been introduced and that their concerns should be expressed to the CIPM. The OIML and the CIE informed the CCU that they were satisfied with the change to liaison status as it fitted with international practice. The President commented that a letter had been sent to the Presidents of the scientific unions on 8 August 2017 replying to their concerns.

It was recalled that the members of the CCU considered it important to be able to vote during its meetings and that this may be lost with the change of status from member to liaison. Document CIPM-D-01 specifically mentions that "*The operation of the CC is normally by consensus (nem. con.) of Members while present at the meeting. If no consensus is reached the CC President may decide to defer to an electronic vote of all Members*." Mr Henson said that some of the confusion over voting came from the wording of CIPM-D-01, which implied that the CCs operate by voting, whereas they actually operate through a consensus-based decision-making process. Prof. Ullrich added that if the text of CIPM-D-01 is changed to remove the emphasis on voting, it will eliminate some of the concerns expressed by the scientific unions. A brief discussion resulted in agreement among the CIPM that if no consensus is reached on important issues during a CC meeting the CC President should refer the issue to the CIPM. The Director reiterated that the text of §5.10 of CIPM-D-01 could be revised to remove the emphasis on voting in the CCs. A decision was drafted to highlight the consultative nature of the CCs and the importance of consensus-based decision-making processes, and to update CIPM-D-01 to remove references to voting in the CCs.

Decision CIPM/106-18 The CIPM decided that, in order to further emphasize the consultative nature of the Consultative Committees and the importance of the consensus-based decision-making processes, Document CIPM-D-01 should be updated so as not to make any reference to voting taking place in CCs.

17. SUMMARY OF APPLICATIONS FOR MEMBERSHIP AND OBSERVERSHIP OF THE CCs

Applications for membership and observership of the CCs were discussed, with the following outcomes.

Decision CIPM/106-19 The CIPM accepted the following changes to the membership and observership of the Consultative Committees:

- CCEM
  - NIS (Egypt) as an observer.
- CCM
  - DFM (Denmark) as a member.
- CCQM
  - VNIIFTRI (Russian Federation) as an observer.
  - SL (Ireland) is no longer a member of the CCQM. (Since Ireland is a Member State, a representative from SL will be able to attend as an observer upon request).
- CCT
  - CMI (Czech Republic) as a member.
- CCTF
  - Chunghwa Telecom Laboratory (Chinese Taipei) as an observer.
- CCU
  - LNE (France) as a member.

18. THE ENGAGEMENT OF STATES WITH VERY-LOW GDP AND WITH EMERGING METROLOGY SYSTEMS (MICRO-CEEMS) IN THE ACTIVITIES OF THE BIPM

Mr Henson presented paper CIPM/17-17.1 "Reflections on the engagement of states with very-low GDP and with emerging metrology systems in the activities of the BIPM." He explained that the purpose of this paper was for the CIPM to consider an amendment to the criteria, originally adopted at the CIPM's 98th and 99th meetings, which they consider when deciding whether to formally encourage Associate States to accede and become Member States. The proposal is to exempt a subset of very 'small'[10] Associate States from the 'escalator'. This escalator, over time, raises Associate State subscriptions to 90 % of that which they would pay as a Member State. Mr Henson pointed out that any decision amending the criteria should still make it clear that such Associate States may still choose to accede at any time if they so wish. This proposed amendment would impact 6 of the 17 Associate States that are currently paying elevated subscriptions due to the escalator mechanism.

Mr Henson continued by explaining that the amended criteria would exempt Associate States with a UN coefficient of 0.02 or less (one fifth of the minimum subscription level for an Associate, one twenty fifth of the minimum for a Member State) from entry onto the escalator.

Mr Henson explained the background of the proposal. He recalled that when the status of Associate State was set up in 1999, consideration was given to affordability, allowing states with relatively small economies to

[10] In this context 'small' refers to the State economic power, moderated by development considerations, as expressed by the UN Scales of Assessment, and does not refer to geographical area or population.

engage in the work of the BIPM. The minimum subscription was set at 0.05 % of the dotation. As of late July 2017, 107 of the 193 states listed by the UN participate in the BIPM's activities, covering 97 % of the world's GDP. In the future, any new Associate States will therefore be drawn almost exclusively from states with limited metrology infrastructure, most of which are classified as developing countries: the remaining 86 states only account for 3 % of global GDP. The status of Associate State was reconsidered by the 23rd CGPM (2007) due to a number of Associate States becoming highly active in the CIPM MRA. It was felt that such states should accede and become Member States, and as a consequence bear a larger and fairer part of the costs. The Resolution adopted (Resolution 5 of the 23rd CGPM (2007)) included, in the 'considerations' the statement '*that the status of Associate State should be a possible first step to accede to the Metre Convention*'. It was decided that the CIPM would review the situation of each Associate State 5 years after its admission as an Associate with a view to encouraging it to accede to the Metre Convention. The CIPM was invited to draw up criteria to implement this process. The issue was considered in detail by the CIPM at its meetings in 2008 and 2009. This led to the adoption of three criteria as the basis for deciding whether a state that had been an Associate for at least 5 years should be formally encouraged to accede. Resolution 4 of the 24th CGPM (2011), created the escalator mechanism whereby Associates that have met the criteria are encouraged to become a Member State. The Resolution states that after an '*initial 5-year period, if the CIPM considers, on the basis of the criteria it adopted, that it would be appropriate for an Associate State to become a State Party to the Metre Convention, the amount of subscription for such an Associate will be progressively and irreversibly increased each year so that it reaches, in five years, an amount equivalent to 90 % of the annual contribution it would pay as a State Party to the Metre Convention*.' This resolution also raised the minimum contribution to 0.1 %.

Since the introduction of the escalator mechanism, two states, Slovenia and Lithuania, have acceded from it and become Member States. In 2011 the subscriptions received from the then 30 Associate States amounted to 190k€, which at the time was not considered to have been sufficient to cover their costs. By 2017 the subscriptions from the 38 Associate States amounted to almost exactly one million euros. In addition the two States that acceded as a result of the escalator mechanism now pay contributions. The actions taken in 2011 have addressed and rebalanced the benefits and costs for Associate States as a group.

Mr Henson commented that there is ongoing interest from states that wish to participate in the activities of the BIPM, particularly the CIPM MRA. He recalled that all the 'larger' states are already engaged as either Member States or Associates and as a consequence, any new Associate States will be 'small' states with limited metrology infrastructure and capabilities, as well as a limited ability to fund their subscriptions. For some time the BIPM has been using the term CEEMS (Countries and Economies with Emerging Metrology Systems). This term was first adopted by the OIML and to avoid confusion, the term is also used by the BIPM. For the purposes of the current discussion a new term 'micro-CEEMS' is proposed to refer to Associate States of the CGPM with a UN coefficient of 0.02 or less. This figure was chosen because it is at a point where the financial impact from a reduction in subscriptions, likely to be balanced in part by diminished risk of exclusion, has been ascertained as acceptable and affordable for the BIPM. There are 21 Associate States with UN coefficients below 0.02 (micro-CEEMS) and there is, by chance, a gap around this figure such that currently no Associate State on the escalator is very close. The figure of 0.02 sets a ratio of a micro-CEEMS to an Associate minimum (0.02 % to 0.1 %) at 5:1, which is also the ratio of the minimum subscription of an Associate State compared with the minimum contribution of a Member State (0.1 % to 0.5 %). Six of the 21 micro-CEEMS are already on the escalator and another three will enter in 2018.

Mr Henson recalled that the BIPM has been involved in a dialogue with these micro-CEEMS and it is clear that in some cases, it is difficult for them to justify the cost benefit of participating in the work of the BIPM as they ascend the escalator. The escalator is intended to lead to accession, yet while these states are able to participate effectively in the CIPM MRA they have generally have limited scope for taking full advantage of participation as a Member State in the foreseeable future. They do not and are not likely to have the capability

to participate in CCs, nor workshops due to financial constraints, and would not be able to benefit from BIPM calibrations as their metrology systems do not operate the sort of equipment the BIPM is able to calibrate. He added that the issue of micro-CEEMS needs to be addressed now because the balance of benefits and costs is not equitable for them, especially after they enter the escalator mechanism.. For example: Jamaica with 22 CMCs (all in mass standards), is on the top step of the escalator in 2017, and has a subscription 47 times its UN coefficient. If the smallest Associate State were to publish CMCs and enter the escalator mechanism it would, on reaching the top step, be paying 420 times its UN coefficient, or if it acceded, 470 times its UN coefficient.

In addition, the payment situation is being made more difficult as time goes by. Historically payments for international organizations were centralized in most countries and paid by the Foreign Ministry. Over time there has been a trend to devolve payments, first to the responsible Ministry, and then in many cases from that Ministry to the metrology institutes. The other important reason for developing a strategy now is that the BIPM will have to deal with many micro-CEEMS in the future: of the 86 states listed by the UN that are neither Member States nor Associates, 72 have UN coefficients of 0.02 % or less. Mr Henson commented that if something is not done to address the situation, certain Associates will almost certainly be lost from BIPM activities.

Mr Henson proposed that the criteria for entry onto the escalator mechanism could be readdressed by the CIPM such that the micro-CEEMS Associate states are not entered onto the escalator. He remarked that the proposed change would not prevent any micro-CEEMS from becoming a Member State if it so chose. The micro-CEEMS that are currently on the escalator would have their subscriptions reduced to the minimum from 2018 and the change would not be retroactive. He highlighted the case of one of the micro-CEEMS states that was approaching three years in arrears and facing exclusion. This state would benefit going forward if the proposed approach were adopted, but might need time to repay the outstanding arrears.

The President thanked Mr Henson and asked for comments and questions. The CIPM discussed the proposal at length and there was broad support, particularly for the fact that it will enable micro-CEEMS to become engaged in the activities of the BIPM and will keep them within the world-wide metrology system. The CIPM members with involvement in AFRIMETS, APMP, EURAMET and SIM commented that the proposal would be supported by these RMOs. It was noted that even with the adoption of this new approach the Associates States as a group would still fully cover the cost of their participation. The CIPM agreed three decisions, which amended the criteria for entry onto the escalator mechanism, reduced the subscription to the minimum for micro-CEEMS already on the escalator, and to develop a rescheduling agreement with any state affected by the previous decision.

Decision CIPM/106-20 The CIPM decided that when considering whether it is appropriate for an Associate State of the General Conference on Weights and Measures (CGPM) to be encouraged to accede to the Metre Convention and hence become a Member State, it will take into account whether it has:

- been an Associate State of the CGPM for at least 5 years,
- a National Metrology Institute (NMI) that has signed the CIPM MRA,
- published comparison results in the key comparison database (KCDB),
- one or more Calibration and Measurement Capability (CMC) listed in the KCDB,
- a percentage higher than 0.02 on the '*Scale of assessments for the apportionment of the expenses of the United Nations'*.

The above criteria will be applied in the implementation of Resolution 4 of the CGPM (2011) '*On the status of Associate State of the General Conference*'.

This decision revises the criteria adopted by the CIPM at its 98th (2009) and 99th (2010) meetings.

The above notwithstanding, the CIPM reaffirmed that an Associate State of the CGPM may choose to accede to the Metre Convention and become a Member State at any time should it so wish.

Decision CIPM/106-21 The CIPM decided that an Associate State of the CGPM that does not meet the criteria set in Decision CIPM/106-20 and that has already been encouraged to accede to the Metre Convention, and as a result is paying an increased subscription, shall have its subscription reduced to the minimum for an Associate State. The reduction will come into force in 2018 and will not be retroactive.

Decision CIPM/106-22 The CIPM asked the BIPM to work with any Associate State included in Decision CIPM/106-21 and that is in arrears in order to establish a rescheduling agreement.

19. DISCUSSION AND APPROVAL OF THE BIPM STRATEGIC PLAN (2018)

The Director presented the draft BIPM Strategic Plan (2018), which had been open for comment on the website since 1 August 2017. He summarized the background to the development of the document and how it fits into the preparations for the 26th CGPM (2018). It had been developed by the BIPM in consultation with the CIPM Sub-Committee for Strategy and the CIPM. It addressed the objectives set out in the Vision, Mission and Objectives of the BIPM that had previously been developed, reviewed and approved by the CIPM at its 105th Meeting (2016). The appropriate CC strategy documents were consulted during the drafting of the document. The detailed strategic plans are presented in terms of plans for the short term (2018-2019) and the strategy for the long term (2020-2025). Four particular priorities considered during the development of the Strategic Plan (2018) were:

- to identify the highest-value activities required by the Member States.
- to review the technical work needed at the BIPM in physical metrology following the expected decision to redefine the base units of the SI at the 26th CGPM (2018).
- to balance the resources committed to the three strategic objectives (liaison, technical collaboration and coordination) with the capacity building and knowledge transfer activities.
- to develop a sustainable long-term financial plan for the operation of the BIPM enabling it to fulfil its mission to 2025.

The Director said that agreement of the Strategic Plan (2018) by the CIPM would allow the BIPM to progress with the development of the Work Programme for the years 2020 to 2023, which would be considered at the 26th CGPM. There was a brief discussion, and with a few minor editorial changes, the CIPM supported the Strategic Plan (2018).

Decision CIPM/106-23 The CIPM agreed the BIPM Strategy (2018) with a change to the text of the final line of the "mission" to read "Improving the quality of life and sustaining the global environment".

20. PREVIEW OF THE LONG-TERM FINANCIAL PLAN FOR THE BIPM

The Director presented a Long-Term Financial Plan for the BIPM covering the period 2020 to 2023. He commented that it had required the development of a model for the BIPM's finances covering the remainder of the current Work Programme (2017 to 2019) and the next (2020 to 2023). It is based on a number

of assumptions for income, staff costs, operating costs and capital spending. No specific assumptions were made about the technical balance of the Work Programme 2020-2023, which has not yet been finalized, except that operating and investment spends will be retained at close to the current levels. The assumptions for income included a flat dotation through to 2022, except for the baseline uplift from accessions. The balance of staff costs, pension costs and operating expenditure has been based on activities that are close to the current level. He said that the effect of not placing micro-CEEMS on the escalator mechanism had been considered.

The Director concluded by saying that the long-term financial plan is being developed in parallel with the BIPM Strategy (2018) and that it will be further refined when the Work Programme 2020-2023 is drafted. The BIPM has managed to control operating costs very well during the delivery of the current Work Programme. He concluded from the modelling that if the BIPM continues with strict controls on spending it will be possible to continue to deliver the present level of activity and maintain its impact and value, even with a "flat-cash" settlement for the next dotation period (2020-2023). He warned that at the end of this period the BIPM will have operated with "flat-cash" support from Member States for a period of 8 years, with only a small increase in subscriptions from Associates on the escalator. Inflation and the need for further capital expenditure suggest that a new financial model will be needed to ensure financial sustainability beyond this period.

The President thanked the Director and commented that it is not sustainable for the BIPM to continue with a "flat-cash" settlement in the long term. The Director was asked to comment on whether the projected deficits could be compensated from the BIPM's reserves. He confirmed that this should be possible. The Chairman of the CIPM Sub-Committee on Finance cautioned that the BIPM's current cash position would be eroded rapidly if the reserves are used for this purpose.

The CIPM returned to the issue of the level of the BIPM reserves, which had been discussed in §5 "Report from the Chair of the CIPM Sub-Committee on Finance". It was recalled that the present policy is that the reserves are 35 % of the dotation. The Sub-Committee had recommended that this should be increased, possibly to 50 %, to reflect the uncertain global political situation. The Director remarked that the level of 35 % is roughly equivalent to the contributions of the four largest Member States and if they delayed their payments for any reason, the reserves would be depleted rapidly. He reiterated that the proposal is to increase the reserves to 50 % of the dotation and the President added that he considered the proposal to be prudent, especially considering the uncertain global political and economic situation. He invited comments. There was some concern about using the term 'reserves' in any discussions involving the dotation in case of any misunderstandings over their intended use: it should be made clear that the reserves have a specific purpose and cannot be used for other purposes such as the Pension Fund. Dr Sené, Chair of the CIPM Sub-Committee on Finance, suggested that there should be a disconnect between what is considered to be a prudent level for the reserves, which are used strictly to allow the BIPM to continue to operate in the event of a "cash shock", such as late or defaulting payments, and the secondary issue of how to explain to Member States the BIPM's cash equivalent. The reserves act as a buffer to allow investments in the BIPM to be made that could not otherwise be funded from the cash stream as well as protecting against late payments. The CIPM decided that the reserves should be raised to 50 % of the dotation and the following decision was agreed.

Decision CIPM/106-24 The CIPM decided to revise the level of reserves shown in the BIPM Financial Report to 50 % of the annual dotation, with immediate effect.

THE 106TH MEETING OF THE CIPM – THIRD DAY – 20 OCTOBER 2017

The President welcomed the CIPM to the third day of its meeting. The meeting was joined by Ms Arlen for §21.

21. AGENDA AND TIMETABLE FOR THE 26TH MEETING OF THE CGPM (2018)

The Director said that he and the President of the CIPM had visited the President of the *Académie des sciences* on Thursday 12 October 2017. As a result, the President of the *Académie des sciences*, M. Sébastien Candel has agreed to act as the President of the 26th meeting of the CGPM as is foreseen in the Metre Convention.

Five draft resolutions for the 26th meeting of the CGPM were presented to the CIPM.

- **Draft Resolution A 'The International System of Units (SI)'**

  This resolution is complete and had been approved by Decision CIPM/106-10. The text will undergo a final legal and institutional review by the BIPM prior to translation.

- **Draft Resolution B 'On the definition of time-scales'**

  This resolution B had previously been reviewed in detail by the CCTF and the CCTF President. It has been translated.

- **Draft Resolution C 'Dotation of the BIPM for the years 2020 to 2023'**

  The Director said that this resolution followed the standard format used at previous CGPM meetings. There were no comments.

- **Draft Resolution D 'On the role, mission and objectives of the BIPM'**

  The Director presented Draft Resolution D and commented that it gives a broad perspective on the work of the BIPM and highlights that its work is a world-wide endeavour. It confirms the objectives of the BIPM as they were agreed by the CIPM in 2016.

  Mr Henson commented that Appendix C of the Report of the 25th meeting of the CGPM (2014) proposed the establishment of a 'BIPM Visitor Programme', which subsequently became the CBKT Programme. This proposal called on other bodies to provide resources but it did not give the BIPM an explicit mandate for the work. The final bullet point in Draft Resolution D gives the BIPM this mandate through the following text *[the CGPM, at its 26th meeting] confirms its support for the increased focus by the BIPM on knowledge transfer and capacity building, and consequent improvements in the efficiency and effectiveness of the CIPM MRA.* The Director added that there is a strong link between the aspirations toward greater world-wide engagement and the BIPM's work in capacity building and knowledge transfer and this is a key message of the draft resolution. A number of editorial changes were discussed and implemented.

- **Draft Resolution E 'On financial arrears of Member States and the process of exclusion'**

  The Director commented that there had been an agreement from the CIPM to prepare a draft resolution on this topic (See §7, Decision CIPM/106-04). A meeting scheduled with the French Ministry of Foreign Affairs on 30 October 2017 will discuss the process for the exclusion of Member States in arrears. A revised draft will be produced and circulated to the CIPM after this meeting.

The President thanked the Director and asked if there were any comments regarding the draft resolutions or the agenda and timetable for the 26th CGPM. Dr May recalled that there had been a discussion at the NMI

Directors' meeting regarding the proposal for micro-CEEMS, as discussed in §18, and the development of a draft resolution on this and the broader subject of the role of Associates. It was suggested that this is not appropriate at the moment as this work is in progress, but the matter could be readdressed in the future, particularly after the work on the redefinitions is complete. Ms Arlen commented that the power to adopt criteria, such as encouragement to accede to the Metre Convention rests with the CIPM. If this were to be addressed in a Draft Resolution, the power to change the criteria would be lost by the CIPM and could only be changed at a meeting of the CGPM. The matter was thoroughly discussed and there was a consensus that a draft resolution is not required at the moment and that the role of Associates will be debated fully at a future meeting of the CIPM.

It was suggested that the content of the CC Presidents' presentations to the CGPM should be harmonized, particularly for any presentations made while the press and media are present. It was further suggested that the content of presentations should be made as understandable as possible, without going into too much detail regarding the underpinning science. The Director said that the bureau had discussed a template for both the presentations and reports. These ideas will be refined and circulated to the CC Presidents. He added that the exact schedule for the presentations by CC Presidents is under discussion because of the number of talks being planned. As a result it may be necessary to reschedule some of the four CC talks currently planned for the Friday morning session to other slots in the agenda.

There was a further discussion on the agenda and timetable for the 26th CGPM, with a focus on emphasizing the significant amount of interesting technical work that has gone into the redefinitions. The Director suggested that the Presidents of the four CCs that are most closely involved in the redefinitions would be a good choice to make these presentations. These talks could highlight work that has been completed as well as why it is important for the future.

22. PREPARATIONS FOR THE ELECTION OF THE CEC AND THE CIPM AT THE 26TH MEETING OF THE CGPM

This agenda item was held in camera. Two decisions were agreed.

Decision CIPM/106-25 The CIPM decided to amend Section B (page 3) of the "Criteria and Process for Election of CIPM Members" (September 2014), by adding the phrase:

"Each member shall be willing to act as the President of a Consultative Committee or of a CIPM Sub-Committee".

Decision CIPM/106-26 The CIPM asked Dr May to reinstate the CIPM *ad hoc* Working Group on Membership to propose some clarification of the text in "Step5: Seating of a newly elected CIPM" in the "Criteria and Process for Election of CIPM Members" for discussion at the next meeting.

23. 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 20 October 2017 in the presence of the President of the CIPM and the Director. (see Appendix 2).

24. REPORTS FROM MEETINGS AND THE CIPM PRIZE SUB-COMMITTEE

Joint Committee of the RMOs and the BIPM (JCRB)

Dr May recalled Action 38/1 from the JCRB meeting in September 2017 "The JCRB requests the CIPM to invite representation from the JCRB to take part in meetings of the CC Presidents in order to encourage communication between the JCRB and the CCs" and noted that this required discussion by the CIPM. Dr May added that both the JCRB and the CCs often work on the same topics relating to implementation of the CIPM MRA and the suggestion to invite the representatives to the CC Presidents' meeting had been made in order to improve dialogue and to allow individual responsibilities to be decided, thus improving efficiency. He postulated that strategic decisions could then be addressed by the CC Presidents (with RMO participation) and the operational issues by the JCRB.

It was agreed that one or two representatives from each RMO should be invited to attend meetings of the CC Presidents and that the invitation should be made through the CIPM President. A clear agenda should be developed for these joint meetings and the representatives should be prepared to discuss technical and quality-system issues.

Decision CIPM/106-27 The CIPM asked the CIPM President to invite each RMO to send one or two representatives to the next meeting of the CC Presidents (19-20 June 2018). These representatives should be prepared to address the recommendations of the review of the CIPM MRA in order to ensure common understanding between the CCs and the RMOs on technical and quality-system issues.

Meeting of NMI Directors and Member State representatives

Dr Louw expressed the opinion that the meeting of NMI Directors and Member State representatives, which had been held on 18-19 October, had been very productive for all involved, but some of the topics covered had been under discussion for several years. It was suggested that in the future, new topics should be found, including matters of specific interest to developing countries and Associates. The President agreed that the meeting had been a success and recalled that it is the NMI Directors who organize the session on the second day and suggest the topics for discussion.

Dr Rastello recalled that the impact of "big data" on metrology had been discussed at the meeting of NMI Directors. She commented that had this been discussed during a CC workshop, a task group would have been established to draft a strategy and asked if something similar should be done to develop the topic and to organize a workshop. The Director said that the timetable for 2018 is full, but it should be considered for 2019.

CIPM Prize Sub-Committee

Dr Bulygin presented some proposed regulations for a metrology awards scheme and some terms of reference for the CIPM Prize Sub-Committee. The vision of the scheme is to involve the NMIs of Member States in the competition in order to promote better understanding of metrology and the importance of international cooperation. The establishment of the scheme should: emphasize the role of CIPM and BIPM among metrologists from the NMIs world-wide; stimulate young scientists from NMIs to strengthen their research activities; promote career growth for talented scientists in NMIs world-wide; and support international cooperation and connectivity among metrologists. The awards would recognize outstanding contributions to the world metrological system in one or more of the following areas: significant research achievements in metrology; work within the CIPM Consultative Committees; metrology capacity building and/or knowledge transfer; and improved or enhanced measurement service delivery.

Dr Bulygin commented that the awards should be judged by the CIPM. He noted that there is limited funding available from the BIPM itself. He suggested that the contest should primarily focus on NMIs from countries with emerging metrological systems and concluded by describing the proposed regulations for participation, nominations, selection and the awards process. Three categories of awards were proposed: outstanding achievements in promoting the revised SI; outstanding achievements in developing metrology for quality of life by a scientist from a state with an emerging metrology system; and a special annual nomination aligned with the topic of world metrology day. It was proposed that the winners should be invited to the BIPM to receive their awards during a CIPM meeting. The terms of reference were presented. He commented that the Sub-Committee will need more members as it currently has only two: Dr Bulygin and Dr Kang.

Dr Bulygin was asked if the awards would apply to Designated Institutes (DIs) as well as NMIs. He confirmed that DIs should be included. The possibility of raising the age limit for nominees was discussed. This would allow the CIPM to make awards to recognize long-term contributions to metrology. It was suggested that nominees from Associates should be allowed, rather than just those from Member States.

The Director said that prizes to encourage the work of young metrologists would have tangible benefits but he cautioned against duplicating the successful award schemes in operation by APMP and COOMET. Dr Liew confirmed that the APMP has an existing award scheme for young metrologists and in 2017 it is introducing a new category specifically for young scientists from countries with developing metrology systems.

Following a further discussion it was agreed that the CIPM will consider the proposal and terms of reference documents and send comments to Dr Bulygin by March 2018. These comments will be summarized and the revised documents sent to the CIPM bureau by June 2018. Dr Liew and Mr Érard agreed to join the Sub-Committee for Awards. The President thanked Dr Bulygin for his work.

Decision CIPM/106-28 The CIPM welcomed the draft of the Regulations for Awards and Terms of Reference of the Sub-Committee for Awards as a basis for further work.

Members of the CIPM agreed to consider the documents and send additions and corrections to Dr Bulygin by March 2018. Dr Bulygin will summarize the proposals from CIPM members and send the final document to the CIPM bureau by June 2018.

The CIPM decided that Dr Liew and Mr Érard should join the Sub-Committee for Awards.

Meeting of the CIPM bureau and RMO Chairs

The President recalled that there had been much discussion at the meeting between the CIPM bureau and the RMO Chairs. In particular, this had included ‘risk-based’ approaches to inter-RMO CMC reviews. He added that the meeting had been useful and there was consensus among the RMO chairs that such meetings should continue.

25. BIPM LIAISON AND COORDINATION REPORT

Mr Henson noted that the 38th JCRB meeting, held in September 2017, had accepted amended text for document CIPM MRA-D-01 "Rules of procedure for the JCRB" to better reflect that the JCRB Terms of Reference require it to work by consensus, which is the normal *modus operandi*, and that voting is only used when consensus cannot be achieved.

Mr Henson spoke about the recent engagement with the Organisation for Economic Co-operation and Development (OECD). The strategic aims of the BIPM's liaison are to have the Metre Convention activities, structures and participants recognized as a critical part of its quality infrastructure (QI) and to use the OECD assembly of international organizations to effectively disseminate information about metrology in the QI context. He remarked that the BIPM will be listed among the organizations used to underpin the OECD's regulatory initiative. An agreement has been reached in principle for the OECD to conduct a study of the BIPM and metrology or the impact of the CIPM MRA through a post-doc position at the BIPM. The liaison with the OECD will also allow the BIPM to participate in Working Groups of the "Partnership for effective international rule-making."

Mr Henson said that the key strategic aim of the recent liaison with European Aviation Safety Agency (EASA) is to have calibrations performed under the CIPM MRA recognized as acceptable within the context of the EASA regulatory framework. The BIPM has provided the EASA with guidance, and it has agreed in principle to accept the CIPM MRA as a basis of accepting calibrations at aircraft repair shops world-wide. The EASA handbook is being revised accordingly.

He presented the International Liaison and Communication Department's key activities and particularly highlighted the impact factor for *Metrologia*, which has increased to 3.411. There is an active programme of *Metrologia* focus issues and he recalled that the input data for the CODATA special adjustment 2017 had been published.

A new brochure "The role of metrology in the context of the 2030 Sustainable Development Goals" has been published in 2017 and was the result of a strategic partnership between the United Nations Industrial Development Organization (UNIDO), the BIPM and the OIML in the field of metrology. The brochure, largely written by the BIPM, highlights the contribution of metrology to the implementation of the 2030 Agenda for Sustainable Development. The partnership enables these three international organizations to coordinate their activities in complementary and mutually supportive areas of operation, in order to enhance the impact of industrial development on economic growth.

Mr Henson then covered a number of other items. He recalled that a new definition of Quality Infrastructure was adopted by DCMAS members and the World Bank in June 2017. He reported that the revision of the international standard ISO/IEC 17025 is almost complete and will be published in late November 2017. He recalled the importance of World Metrology Day in 2018, which will 'kick off' the publicity campaign for the redefinition of the SI. The five posters submitted through the competition organized by EURAMET for World Metrology Day 2018 were presented, including the winning concept from METAS, the Swiss NMI. He remarked that the selection team had been very impressed with all the submissions and he hoped some of the other ideas submitted could be used in some other way. He concluded his presentation by acknowledging the importance of liaisons carried out throughout the BIPM scientific departments, and the support from the IT, finance and administration sections of the BIPM. The President thanked Mr Henson and the International Liaison and Communication Department for the increasing amount of work they have undertaken and noted that the benefits of this work are being seen.

26. DATE FOR MEETINGS IN 2018 AND 2019

2018

12-13 March	CIPM *ad hoc* Working Group on Implementing the Recommendations from the Review of the CIPM MRA
14-16 March	39th meeting of the JCRB
18 June	CIPM Sub-Committee on Finance
19-20 June	Consultative Committee Presidents meeting
21-22 June	107th meeting of the CIPM (one session)
13-16 November	26th meeting of the CGPM

2019

20-21 March	108th meeting of the CIPM (Session I)
22 March	Meeting of the new CIPM bureau
Week 42	108th meeting of the CIPM (Session II)

It was agreed that there will not be a meeting of the CIPM bureau and RMO Chairs in 2018 unless it is specifically requested. If this is the case, it could be combined with the meeting of the JCRB in March 2018.

27. ANY OTHER BUSINESS

The Director presented Document CIPM/17-23.1 "The CIPM position on the VIM" for discussion. The CIPM agreed that the document represented its position on the revision of the International Vocabulary of Metrology (VIM).

Decision CIPM/106-29 The CIPM accepted document CIPM/17-23.1 as its position on revision of the International Vocabulary of Metrology (VIM).

Dr Richard asked if the Director will be working with communications specialists to formulate a detailed plan for the final day of the 26th CGPM. The Director confirmed that this is the case and said that most of the ideas for the session have been developed along with the four members of the PR Expert Group.

Dr Richard proposed that in the future, the draft decisions should be made available to CIPM members in advance of its meetings. The President remarked that many of the decisions result from discussions during CIPM meetings and that it is not always possible to develop them in advance. He commented that other draft decisions are only developed during bureau meetings, which are held immediately before meetings of the CIPM. There could be a delay introduced between bureau meetings and the CIPM to allow circulation of any decisions that arise, but this would be difficult in terms of travel arrangements. In addition, developing decisions in advance could lead to criticism from members of the CIPM that they have not had sufficient input into the decision making process. Following a discussion, it was agreed that decisions should be made available in advance whenever possible.

The President thanked the administration team for their support during the meeting, wished everyone safe travel and closed the meeting at 18:15.

Appendix 1

REPORT OF THE SECRETARY AND ACTIVITIES OF THE BUREAU OF THE CIPM

(October 2016 - October 2017)

The CIPM bureau met at the BIPM on 9-10 March 2017, 12 and 14 June 2017 and 13-15 October 2017.

The Secretary attended the Management Review meetings of the BIPM Quality and Occupational Health and Safety Systems. In addition, the President, Secretary and one of the Vice Presidents attended the annual bilateral meeting with the ILAC, the quadripartite BIPM/OIML/ILAC/ISO meeting and an informal bilateral meeting with the OIML in March 2017.

In June 2017 Bureau members attended a meeting of the Finance Subcommittee and the CC Presidents meeting. (There is a separate report of the latter meeting).

The agendas of the bureau meetings included the usual administrative and financial matters; the following paragraphs summarize other agenda items.

BIPM Pension Plan

Mr Érard, the Chair of the Pension Fund Advisory Board (PFAB), attended the parts of the meetings devoted to this agenda item. The PFAB met in February and September 2017. The main agenda item was the presentation of a counter-proposal by the Committee for Conditions of Employment (CCE) on behalf of the staff. On 10 March, the bureau members and Mr Érard met with five members of the CCE for a second presentation of the counter-proposal. One element of the proposal was replacement of the PFAB by a "Joint Executive Committee" comprising four employer and four employee/pensioner representatives that would report directly to the CGPM, i.e., not to the CIPM. A second element was the elimination of the planned annual increases after 2019 until the actuarial study planned for 2019 has been completed. A third element was the involvement of pensioners in the discussions of revisions to the pension plan. The fourth element was a request for some non-financial compensations, e.g., additional days of paid leave over the Christmas/New Year's period.

The response by the bureau members and Mr Érard included several observations but no commitment to any changes to the currently proposed conditions. First, the impracticality of reporting to a body that meets only once every four years was noted. Secondly, it was noted that further increases to the contribution rates after 2019 are necessary to demonstrate sustainability of the pension fund to the CGPM at its 2018 meeting. Thirdly, current plans already include engagement of the pensioners in 2017. Finally, the Director reminded the CCE members that he had agreed to consider non-financial compensations upon receipt of a detailed proposal from the CCE.

In June 2017, discussion covered the CCE's request for greater representation by staff and pensioners on the Pension Fund Advisory Board. This was aided by a table prepared by the BIPM Legal Adviser which showed the composition of the pension fund boards of several intergovernmental organizations.

In October 2017, the discussion covered four points: the CCE's request for greater representation by staff and pensioners on the PFAB; a report of election of a pensioner representative; revised terms of reference for the PFAB; and a two-year freeze on increases to the cost-of-living adjustments to pensions.

The BIPM Committee on Conditions of Employment (CCE) has provided an advisory opinion on the composition of the PFAB and the "splitting of the point" to facilitate a freeze in cost of living adjustments to pension benefits.

Dr Thomas Witt was acclaimed by the BIPM pensioners to represent them on the PFAB and attended the September 2017 meeting of the PFAB as an observer. His appointment as a member was subsequently approved by the CIPM.

The revised terms of reference for the PFAB need to be approved by the CIPM, as do changes to the Rules, Regulations and Instructions that will permit implementation of the 2-year freeze on adjustments to the "point" (i.e., cost-of-living adjustments) on pension benefits.

The bureau accepted a request from the CCE to make a presentation on 14 October.

BIPM Strategy and Work Programme (2020-2023)

In March 2017, the Director presented a flow chart for development of the BIPM Strategy and Work Programme for 2020-2023 that will be presented at the 26th CGPM (2018). The updated version of the strategy includes a commitment to balance the resources allocated to strategic objectives (coordination, liaison and technical collaboration), whilst taking account of: the needs of countries and economies with emerging metrology systems; the need for greater flexibility in the BIPM funding model to take advantage of donor-funded projects; and the need for all BIPM departments to be involved in knowledge transfer and capacity building activities. The Strategy includes a commitment to review the technical work needed at the BIPM following the expected SI redefinitions. The Strategy needs to be reviewed and approved by the CIPM at its 2017 meeting.

Discussion of the proposed strategy led to a decision to include a discussion, at the 2017 CIPM meeting, of the roles and responsibilities of the CIPM, in particular the CIPM Sub-Committee for Strategy, in strategy development.

At the June 2017 bureau meeting, the Director responded to comments received from CIPM members on the BIPM Strategy and Work Programme for 2020-2023 that will be presented at the 26th CGPM (2018). A revised version taking account of the majority of comments will be the subject of consultation with the NMIs in August/September 2017. Some other longer-term issues that were raised will be discussed at a future CIPM meeting.

CIPM Position on the VIM

The bureau reviewed a draft version of a document intended to provide guidance to JCGM-WG2 (Vocabulary) on further development of the VIM. It emphasized the following principles:

1. The terms listed in the VIM should match as closely as possible those in current use.
2. Definitions should be more understandable (than they are in VIM3), without the need to look up the meaning of several other terms.
3. Only a limited number of terms of nominal properties should be introduced.

The document will be circulated to the CIPM for review and approval prior to circulation to WG2 before its May 2017 meeting.

BIPM Staff

The March 2017 bureau meeting heard that Ms Rahima Guliyeva, had joined the International Liaison and Communication (ILC) Department on a two-year term appointment as a liaison officer. The new JCRB Executive Secretary, Dr Nikita Zviagin, arrived in January 2017. Recruitment of a Communications Officer after the departure of Ms Nina De Sousa Dias in April 2017 is planned. A new employee (Ms Johanna Goncalves) has joined the Time Department and recruitment of new Directors for the Time and Ionizing Radiation Departments is under way.

An update at the June meeting reported that excellent candidates have been recruited as Directors for the Time and Ionizing Radiation Departments. The new Director for the Time Department (from 1 November 2017) will

be Dr Patrizia Tavella, currently a Research Director at INRIM (Italy). The new Director for the Ionizing Radiation Department (from 15 August 2017) will be Dr Steven Judge, currently Leader of the Nuclear Metrology Group at the NPL (UK). Ms Justine Evans has been recruited as a communications specialist in the International Liaison and Coordination Department. Other recruitments planned for the near future are for a junior accountant, a technician in the Mass Department, and a scientist for the Chemistry Department. The Procurement Officer position has been declared redundant. A technician is needed for the Mass Department because a "half-staff" member has been transferred to the Chemistry Department. The new Chemist will replace Dr Norbert Stoppacher, who has accepted a position in the private sector.

The Director noted the significant increase in the number of fixed-term employees since he assumed the position in 2013, as well as marked increase in the number of secondees. Seven of the 74 employees are on fixed-term contracts. Secondments, expressed in terms of full-time equivalents, have risen from four to 12 over the past four years.

Capacity Building and Knowledge Transfer Programme

The ILC Department Director presented an impressive summary of the projects completed or in progress in the Capacity Building and Knowledge Transfer (CBKT) Programme. Eighteen participants, the majority from the AFRIMETS and SIM regions, attended the first offering of the 11-day *Leaders of Tomorrow* course, held at the BIPM in November 2016. At the request of EURAMET, a condensed (4-day) version of the course was presented to 18 participants in February 2017. Feedback from participants on both courses was very positive. Good progress in laboratory-based projects was also reported.

Countries and Economies with Emerging Metrology Systems

At the March meeting of the bureau, the Director suggested that there may be a need to develop a less expensive way for countries and economies with emerging metrology systems (CEEMS) to participate in the Metre Convention. At present, the minimum annual contribution to the BIPM dotation for a Member is 56 k€, i.e., about one twentieth of the largest contribution, whereas the UN coefficients of many CEEMS are more than 20 times smaller than the largest UN coefficient. The Director and the ILC Department Director will establish a working group to develop a proposal to address the needs and concerns of this group, described as micro-CEEMS.

At its June meeting the bureau discussed a paper prepared by Mr Henson on challenges facing states with emerging metrology systems but very low GDP (the so-called "micro-CEEMS"). The main implication of his analysis is that the current practice of placing Associate States of the CGPM on an escalating scale of subscriptions once certain conditions have been met may not be appropriate for micro-CEEMS who wish to participate in the MRA. (These conditions were established by means of a resolution at the 24th CGPM in 2011). The CIPM will be asked to consider a proposal to modify these conditions to allow Associate States with a UN coefficient of 0.02 or less, but which meet the other criteria for placement on the escalating scale of subscriptions, to be exempted from this placement.

SI Redefinitions

At its June meeting, the bureau reviewed CCM and CCT recommendations regarding the redefinition of the kilogram and the kelvin, as well as recent Kibble balance and silicon sphere results for the determination of the Planck constant *h*. The latest results for *h* had led to opinions in some quarters that discrepancies need to be resolved before a date for the redefinition of the kilogram is fixed. A recommendation by the CCU will be available at the time of the October 2017 CIPM meeting.

Prof. Ullrich presented a report of the CCU meeting held at the beginning of September to the October bureau meeting; the same report will be presented to the CIPM on 16 October.

BIPM Institutional Matters

The bureau also developed a draft resolution for the 26th CGPM (2018) that would enable the CIPM to revert to the process specified in the Metre Convention for exclusion of a Member State that is six years in arrears in its contributions to the BIPM dotation. The resolution would also instruct the CIPM to undertake a review of the BIPM financial reports in order to rectify the accounts in any case in which the treatment of a Member State has resulted in unjustified arrears. These changes would allow for equitable treatment of Member States in arrears and reduce the complexity of the financial management of arrears.

CIPM Matters

The bureau reviewed two draft decisions that would apply to all of the Consultative Committees (CCs) after approval by the CIPM. The first of these would establish a set of objectives common to all the CCs; the second would harmonize policy for engagement of international organizations as "liaison" members of CCs. After approval by the CIPM, Document CIPM-D-01 would be updated accordingly.

The Use of the Name "BIPM"

On the afternoon of 15 October, the bureau heard presentations from Dr Terry Quinn and the BIPM Legal Advisor in which differing views on the use of the phrase Bureau international des poids et mesures (or its abbreviated form, BIPM) were presented. The presentations drew on a large number of historical documents, including the Metre Convention, reports of meetings and more recent communications between the BIPM and other organizations, including the French Ministry of Foreign Affairs.

There is no disagreement that the Metre Convention created an intergovernmental organization that comprises three organs: the CGPM, the CIPM and the institute located at Sèvres. There is, however, a disagreement about the use of "BIPM". Dr Quinn contends that the BIPM is solely the name given to the institute in Sèvres. The BIPM Legal Advisor contends that the BIPM is the name of the IGO created by the Metre Convention but that the long-established practice of also referring to the facilities in Sèvres as the BIPM presents no difficulties from a legal point of view.

Appendix 2

Visite du dépôt des prototypes métriques

PROCES-VERBAL

Le 20 octobre 2017 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 caveau :

température actuelle	:	21 °C
température maximale	:	21 °C
température minimale	:	19 °C
état hygrométrique	:	57 %

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