Bureau international des poids et mesures

Director's Report on the Activity and Management of the International Bureau of Weights and Measures

(1 January 2012 – 31 December 2012)

BIPM Director's Report 2012

This BIPM Director's Report describes the activity of the BIPM and is one of a set of three documents issued annually by the CIPM and the BIPM which collectively cover the formal reporting to Member States, the other two reports in the set being the:

- Report of the 101st Meeting of the International Committee for Weights and Measures (June and October 2012), and the
- *Rapport annuel aux gouvernements des hautes parties contractantes sur la situation administrative et financière du Bureau international des poids et mesures 2012*.

Note on the use of the English text

To make its work more widely accessible the International Committee for Weights and Measures publishes an English version of these reports.

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

Executive Summary

This year has been an important one for the BIPM as we have started to address the issues that emerged from the meeting of the General Conference on Weights and Measures (CGPM) in October 2011. Details of the *ad hoc* Working Group established by the CIPM following the CGPM are included in this report and the minutes of the CIPM meetings held in 2012. Under the leadership of the CIPM, this initiative has already started to influence the work of the BIPM, and I am sure that, as a result, we will see a BIPM that is responsive to the needs of the Member States, is more transparent and is operated efficiently.

Greater efficiency in all of our activities at the BIPM is vital as our budget for the years 2013 to 2015 reflects the very difficult global economic climate and is less than requested. I am glad to say that through careful management and internal savings we have minimized the impact on the BIPM laboratory programme.

With so much focus on the work of the *ad hoc* Working Group and its implications for the future of the BIPM, we should not forget that 2012 was also successful for the BIPM laboratories. We made good progress on the watt balance project and the ensemble of reference mass standards needed to support the redefinition of the kilogram. We achieved the first full assembly of the calculable capacitor, successful trialling of the new Rapid UTC service, installed the long-awaited ^{60}Co source and validated the new primary facility that underpins air quality measurements. The year has not been without its challenges however, notably a number of our scientific activities were delayed by the world-wide shortage of helium.

This year has seen a continued strengthening of our long-term relationships with international and intergovernmental bodies. We signed a Memorandum of Understanding with the International Atomic Energy Agency (IAEA) which formalizes more than 50 years of close working relations in the field of radiation measurements and setting out opportunities for future collaborations. We continue to work closely with the International Organization of Legal Metrology (OIML) on a wide variety of areas of mutual interest; we reaffirmed our MoU with the International Laboratory Accreditation Cooperation (ILAC), and continue our dialogue on the measurement of Essential Climate Variables with the World Meteorological Organization (WMO) as well as interacting with almost 30 other international or intergovernmental bodies.

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on the Activity and Management
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# of Weights and Measures

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1. INTRODUCTION

1.1. General introduction and overview of 2012

The mission of the BIPM is to provide support to, and improve uniformity of measurement world-wide. To succeed in such an ambitious goal as to achieve uniformity of measurement is crucial to many areas of importance to society including international commerce and trade, the monitoring of climate change and the environment, human health and safety, medicine, food, and scientific research and development. The staff of the BIPM achieve these aims through the work carried out in its scientific laboratories located at its headquarters in Sèvres, France, and through its collaboration with many intergovernmental organizations and international bodies. The BIPM is also actively involved in coordination of the activities of the National Metrology Institutes (NMIs) of States Parties to the Metre Convention. The BIPM maintains scientific facilities in the fields of mass, time, electricity, ionizing radiation, and chemistry. It undertakes metrological comparisons and calibrations in these areas, providing the results to NMIs to support the traceability of measurements to the International System of Units (SI). An important role of the BIPM is to coordinate global metrology, which it does through the operation of the Mutual Recognition Arrangement of national measurement standards and of calibration and measurement certificates issued for National Metrology Institutes (CIPM MRA).

An important activity for the BIPM during 2012 has been to support an *ad hoc* Working Group in its work to review the role, mission, objectives, long-term financial stability, strategic direction and governance of the BIPM. This *ad hoc* Working Group was set up following a resolution passed at the 24th meeting of the General Conference on Weights and Measures (CGPM) held in October 2011. The *ad hoc* Working Group was chaired by the President of the CIPM and was composed of a number of representatives from Member States and NMI Directors together with the CIPM Secretary and the BIPM Director. It met at the BIPM headquarters in March 2012 and produced a set of findings and twenty recommendations for consideration by the CIPM. These were circulated to all Member States and NMI Directors and were discussed at a meeting held at the BIPM headquarters in October 2012.

The recommendations of the *ad hoc* Working Group and the outcomes of the meeting of representatives of Member States and NMI Directors were at the centre of the discussion by the CIPM in Session II of its 101st meeting. These recommendations are leading to important changes in the operation of the CIPM. They are also influencing the way the BIPM reports to its stakeholders and the way it develops its strategy and its work programme. In these respects, they will influence the future course of the BIPM and CIPM for years to come.

This is my last report on the work of the BIPM as I will be retiring at the end of December 2012. I wish my successor, Martin Milton, every success as he takes over as the thirteenth Director of the BIPM from 1 January 2013.

Although the activities of the BIPM are only summarized in this report, I encourage readers to visit the BIPM website (http://www.bipm.org/) for extended reports.

1.2. Travel by the Director and Deputy Director in 2012

Details of travel by the Director and Deputy Director in 2012 are available from the BIPM website: http://www.bipm.org/en/publications/directors_report/travel.html.

2. LABORATORY WORK AT THE BIPM

In order to carry out its mission the BIPM operates laboratories in the fields of mass, time, electricity, ionizing radiation and chemistry. At the core of the BIPM's activities are the provision of traceability to the SI both by direct dissemination, as is carried out in the Mass Department and Time Department, and through the coordination of comparisons of national measurement standards as is carried out in the Electricity, Ionizing Radiation and Chemistry Departments.

Section 2 of this report addresses the work of the BIPM's scientific Departments (Mass, Time, Electricity, Ionizing Radiation and Chemistry) and the watt balance. Extended reports of the work of each department are available at http://www/bipm.org/en/publications/directors_report/.

2.1. Mass

The BIPM has been the custodian of the international prototype of the kilogram since 1889. To ensure the dissemination of the mass unit, the Mass Department provides calibrated 1 kg Pt-Ir prototypes to Member States and calibrates 1 kg national standards on demand.

The innovations in the programme of work 2009 to 2012 were driven by the probability that the kilogram will soon be redefined in terms of a fundamental constant of physics. The programme of work of the Mass Department will ensure that the kilogram unit continues to be disseminated and that the hierarchy, coherence and traceability of the world's mass metrology system will be preserved after any redefinition.

Within the framework of the expected new definition of the kilogram, the Mass Department has been involved in preparing the draft of the accompanying *mise en pratique*. This draft was submitted for comment to the participants of a workshop on the *mise en pratique* of the new definition of the kilogram held at the BIPM headquarters on 21 to 22 November 2012.

The Mass Department has achieved significant progress in the BIPM watt balance experiment and with the Department's ensemble of reference mass standards. The Department continues to modernize by investing in facilities used for the mass unit dissemination. It continues to be active in international cooperation and coordination activities.

In 2011, the CGPM encouraged the BIPM '*to develop a pool of reference standards to facilitate the dissemination of the unit of mass when redefined*' (Resolution 1). The fully automated storage network for the standards was completed in 2012 and three independent circuits (argon, nitrogen and vacuum) have been tested. The impurity of the gases (provided by ultrapure argon and nitrogen cylinders) which flow through the storage containers is below 2×10^{-6} mol/mol and 0.06×10^{-6} mol/mol for the moisture and oxygen contaminants, respectively. A spectrum of hydrocarbon impurities, obtained automatically from a gas chromatograph coupled to a flame ionization detector, tracks the three main contaminants. The purity of the vacuum network is automatically monitored by using a residual gas analyser. The maximum partial pressure detected is below 1.0×10^{-4} Pa.

The network, composed of 12 containers, is ready to receive its 1 kg reference mass standards. The volume and mass of the four Pt-Ir and four stainless steel mass references have been calibrated and the study of their respective mass stabilities in air is under way. The manufacture and characterization of the four single-crystal spheres made from natural silicon is ongoing, and the spheres should be delivered in 2013. In addition to these mass references, two surface artefacts in Pt-Ir and stainless steel have been characterized. Compared to standards of the same material, the increased surface area of these artefacts makes them more sensitive to contamination. The next step is to follow the evolution in mass of the mass

references as a function of their material and storage conditions.

The BIPM is developing a watt balance to assure a primary realization of the new kilogram. The Mass Department devotes 40 % (two full-time equivalents) of its resources to the watt balance project, which represents the major contribution to the experiment from any BIPM department. Significant progress was made with different components of this experiment in 2012 and several important tests were carried out to improve the apparatus and to confirm the feasibility of the BIPM's novel watt balance design. In 2013 the budget and management of the watt balance project will be fully integrated into the Mass Department and the project will no longer be part of a separate departmental structure. Further technical information on the watt balance is given in §2.4 of this report.

The M-one 6V-LL mass comparator from Mettler-Toledo was commissioned in 2012 and it is now fully operational. Auxiliary determinations of the volume, the location of the centre of gravity and the magnetic properties of standards, were made at the request of NMIs. In addition, the Mass Department provided calibration services for pressure and humidity to users in the BIPM scientific departments. Measurement facilities used to support calibration and research programmes have been improved in accordance with the BIPM Quality Management System.

The BIPM is the pilot laboratory for the key comparison CCM.M-K4 which involved 16 participants organized into four petals. Each participating NMI has determined the masses of two 1 kg mass standards in stainless steel. The eight travelling standards were sent to the first four participants in September 2011 and were returned to the BIPM by the last four participants by April 2012. Reports from all 16 participants have been received and Draft A is in preparation. The BIPM also participated in the Inter-American Metrology System (SIM) supplementary comparison SIM.M.M-S9, where the measurands are magnetic properties of a selection of mass standards. This comparison is expected to be completed by the end of 2012.

The Mass Department continued to contribute to the International Avogadro Coordination (IAC) project. A new Memorandum of Understanding for '*Cooperation to Determine the Avogadro Constant using an Isotopically Enriched Silicon Crystal*' was signed in January 2012 by representatives of the INRIM (Italy), the NMIA (Australia), the PTB (Germany), the NMIJ (Japan) and the BIPM. In addition, a 'Right of use Agreement' for all samples and residuals of the isotopically enriched ^{28}Si crystal was signed in February 2012 by representatives of the IRMM, the NMIA, the PTB, the NMIJ, the INRIM and the BIPM.

Within the framework of the Avogadro project, a special study has been conducted to evaluate physical and chemical water vapour sorption effects between air-vacuum cycles, using a 1 kg single-crystal sphere made of natural silicon. The amount of irreversibly adsorbed water on a silicon sphere at room temperature can be deduced from the mass difference of the sphere under vacuum prior to and subsequent to baking it under vacuum at 400 °C for two hours without any further contact with moist air. So far, neither significant nor repeatable results have been obtained and the study is continuing.

The BIPM continued the trilateral cooperation with the NPL (UK) and the METAS (Switzerland) during 2012 to support the *mise en pratique* of the new definition of the kilogram. Studies comparing the cleaning efficiency of different techniques, the rate of recontamination after cleaning, and the mass stability during and after cycles of weighing in air and in vacuum have been carried out on selected materials, such as single-crystal silicon, Pt-Ir and stainless steel. These studies included sorption effects between air and vacuum. Additionally, a study of different storage conditions is ongoing. In 2013, these studies will continue under the European Metrology Research Programme (EMRP) as part of the Joint Research Project (JRP) designated as SIB-05 (NewKILO): '*Developing a practical means of disseminating the redefined kilogram*', instead of being within the framework of the formal trilateral cooperation. SIB-05 will run from June 2012 to May 2015.

In addition to the permanent activities mentioned above, the Mass Department provides scientific and organizational support to both the Consultative Committee for Mass and Related Quantities (CCM) and the Consultative Committee for Thermometry (CCT). More specifically the Department contributes to the work of: the CCM WG on Mass Standards (including Task Groups 1 and 2), the CCM WG on Changes to the SI kilogram and the CCM WG on Strategy; and for the CCT, to the work of the Task Group on the SI, the WG on Strategy and WG 4 (Thermodynamic temperature determinations).

2.2. Time

The end of 2012 marked 25 years of uninterrupted publication of BIPM *Circular T*, a publication produced by the Time Department that gives traceability to the SI second via Coordinated Universal Time (UTC) to its local realizations in national laboratories. It represents the only key comparison on time CCTF-K001.UTC. It is the most frequent key comparison, with one evaluation of the key comparison reference value UTC and the degrees of equivalence [*UTC* - *UTC*(*k*)] every five days for 72 participants, that together contribute data from some 400 atomic clocks. The BIPM received full responsibility for the calculation and publication of results from the Consultative Committee for Time and Frequency (CCTF). Some 13 primary frequency standards contribute to International Atomic Time (TAI), with an average of three to four caesium fountains reporting measurements each month. The frequency stability of TAI is estimated to be 3 parts in 10^{16} for averaging times of one month, and its frequency accuracy is in the low 10^{-16}. Observations of Global Positioning System (GPS) and Global Navigation Satellite System (GLONASS) satellites together with the Two-way Satellite Time and Frequency Transfer (TWSTFT) technique have been regularly used in the calculation of TAI. Since the beginning of 2012 combined links have been progressively introduced in the calculation; at the end of 2012 the combinations GPS/GLONASS and TW/GPS PPP serve to calculate 28 % of the links in TAI. The GPS Precise Positioning Technique (GPS PPP) is in use for TAI clock comparisons in some 20 links, where the statistical uncertainty of time transfer is below the nanosecond; the type B uncertainty of a calibrated TW link is typically 1 ns. The combination of these two techniques results in a 1 ns level combined uncertainty.

The algorithm for the calculation of TAI/UTC is being revised. In August 2011 a quadratic clock frequency prediction model applied to all clocks was introduced in the algorithm. This resulted in a major improvement in the quality of TAI: stopping the drift observed in the free atomic time scale (EAL) that had reached a daily rate of -1.3×10^{-17}. To conclude the revision, studies have led to a new procedure for fixing clock weights, based on the principle that a good clock is a predictable clock rather than a stable clock. These changes have led to a 35 % improvement in the stability of TAI.

During 2012 the LNE-SYRTE (France) provided reports of rubidium frequency measurements obtained with a double Cs-Rb fountain. The Time Department designed the procedure for comparing these measurements to the frequency of TAI, and started publishing the results in *Circular T* after gaining approval for the reports from the relevant CCTF Working Group.

A major achievement of the Time Department is the calculation of rapid UTC (UTCr) under the framework of a pilot experiment that began in January 2012. Nearly 60 % of the laboratories regularly contributing to UTC participate in the experiment. This has resulted in the regular publication of the differences [*UTCr* - *UTC*(*k*)] without delay every Wednesday since February 2012. A preliminary report was approved by the CCTF, which recommended the submission of a final report in 2013 prior to declaring UTCr a permanent product of the Time Department.

International coordination is another leading activity in the Time Department, in particular on the recommendation for a new definition of UTC, without leap seconds, conducted in cooperation with the International Telecommunication Union (ITU) and the International Astronomical Union (IAU).

An updated list of frequencies, mostly in the optical domain, was recommended for secondary representations of the second in 2012. This will provide the basis for a future discussion on the redefinition of the second. These standards, accurate to a level of parts in 10^{17}, can be compared taking full advantage of their qualities only if time and frequency transfer improve by about two orders of magnitude. The Time Department participates in the studies involved to make this improvement a reality.

2.3. Electricity

The work of the Electricity Department focuses on the comparison programme to validate national primary standards for fundamental electrical quantities (voltage, resistance, capacitance), conducting calibrations for the same quantities for the NMIs of States Parties to the Metre Convention, and support for the BIPM watt balance and the calculable capacitor, the latter of which has been developed in collaboration with the NMIA.

Five comparisons were carried out and the results of four previous comparisons published in 2012. The Electricity Department issued 45 calibration certificates for 13 NMIs. These numbers are somewhat lower than usual due to the absence of one staff member who has been working as a guest researcher at the NIST for one year starting in July 2012, and due to a temporary interruption of the resistance comparison and calibration measurements because of problems with the air conditioning in the laboratory. BIPM comparisons (for NMIs which have their own primary realizations) and calibrations (for those NMIs which do not have their own primary realizations) are based on the same primary standards and are therefore an efficient means to contribute to the world-wide uniformity of measurements in the field of electricity.

The BIPM has been asked by NMIs that are members of the Consultative Committee for Electricity and Magnetism (CCEM) to resume the BIPM.EM-K12 on-site comparison of quantum Hall resistance standards, because this is the only way to verify the intrinsic very high accuracy of these systems. For this purpose, a new transportable 1 Hz resistance bridge had been built in 2011 and three thermally stabilized enclosures for transfer resistors, capable of maintaining a temperature stability of 1 mK, were constructed in 2012. Resistance elements to be installed in the enclosures have been tested but the temporal stability and the temperature coefficient did not fulfil expectations based on the manufacturer's specifications and is under investigation by the manufacturer. The initial on-site quantum Hall resistance comparison is planned for 2013.

During 2011 the BIPM participated in a EURAMET supplementary comparison of capacitance standards traceable to the quantized Hall resistance (EURAMET.EM-S31), which was carried out under the framework of an EMRP Joint Research Project on the realization of the new SI ampere. The results of this comparison have shown some unexpected discrepancies. One possible explanation for the discrepancies is related to the frequency dependence of resistors, which is a crucial issue in the traceability chain from the quantized Hall resistance to ac capacitance. The Electricity Department is collaborating with three NMIs to investigate this effect. The results of this work are of great importance for the BIPM's future determination of the von Klitzing constant R_K, using the calculable capacitor.

The Electricity Department is developing a Josephson voltage standard for the BIPM watt balance, which will measure the induced voltage while the coil is travelling through the magnetic field. The programmable Josephson voltage standard will be set to a quantized voltage step close to the voltage on the coil, but with opposite polarity. The small voltage difference will be measured with a nanovoltmeter. The system is based on a programmable Josephson voltage array of the SNS-type (superconductor-normal conductor-superconductor) provided by the NIST. This array has 13 segments of junctions, the output voltages of which can be independently selected by individual bias currents. The different combinations of the 13 segment voltages allow any output voltage within the range

occurring on the watt balance coil with a resolution of 35 μV to be obtained. The bias current source with 13 independent current channels has been tested and is now operational. The SNS array has been damaged as a consequence of the large number of thermal cycles it had undergone and will be replaced by the NIST (United States of America).

Dr S. Solve has been seconded to the NIST as a guest researcher for a year. The appointment began in July 2012. During this time he will be trained in the use of SNS arrays in the field of synthesis of ac voltages and their applications, in preparation for a future BIPM comparison in this field. The work had initially focused on the characterization of a 20 bit digitizer, used to measure the difference between a synthesized stepwise sinusoidal waveform of a programmable Josephson voltage standard (PJVS) and the sine-wave generated by a calibrator. A detailed study of the effects of leakage resistance to ground of a 10 V programmable Josephson array was carried out and a number of conclusions were made. These were useful in reducing measurement errors caused by this effect. The procedure to test for leakage resistance to ground has been integrated into the NIST PJVS measurement software.

The BIPM and the NMIA have been collaborating on the construction of two calculable capacitors of improved design, which are capable of measuring the von Klitzing constant with an uncertainty in the order of 1 part in 10^8, a highly relevant result for the *mise en pratique* of the electrical units. The BIPM system is now fully assembled and mechanical problems related to the sensitivity to vibrations of the moveable lower guard electrode have been resolved. The optical cavity is now sufficiently stable to allow the servo to maintain the cavity length to an integer number of interference fringes over several hours. Significant progress has been made in developing an original alignment technique to ensure that the optical length measured with the interferometer is the same as the electrical length that defines the capacitance change. With the optical system aligned, the interferometer servo working, and the capacitor under vacuum, the first measurements were made with the complete system. A capacitance bridge which had been developed at the start of the project, but which was never fully tested, has been successfully used to compare a 1 pF capacitor with the capacitance change of 0.4 pF given by the calculable capacitor. The result obtained for the 1 pF capacitor can be compared with the value obtained from the quantized Hall resistance (based on the von Klitzing constant R_K) via a quadrature bridge. The results agreed to better than 2 parts in 10^8, which is a very encouraging first result, but cannot be considered as a valid measurement of R_K because an uncertainty budget has not yet been established. As a next step, the capacitor will be dismantled and all parts will be carefully cleaned and rigorously aligned. Work will then continue towards a complete R_K determination in 2013.

2.4. Watt balance

A highlight for the watt balance project in 2012 was the installation of the new vacuum chamber in the new dedicated watt balance laboratory. This laboratory provides better environmental conditions than the previous location, in particular better temperature control and less vibration. The vacuum chamber has been installed in the laboratory and found to be leak-tight at a level of 0.02 Pa, following the repair of a leak. The watt balance is presently being transferred from its previous location to the vacuum chamber. A series of measurements is planned as soon as possible to compare the behaviour of the apparatus in its new location with the behaviour previously observed. This will be followed by the addition of other functional elements to the experiment, in particular an automatic alignment system, which will allow a reduction in the alignment uncertainty, and a mass exchanger.

The parts for the yoke of the definitive magnetic circuit are being fabricated and are expected to be completed at the end of 2012. The samarium cobalt (SmCo) magnets are already available at the BIPM and the complete system will be assembled during the first half of 2013. The new magnet will then be integrated into the watt balance. Its design should lead to a noise reduction in the measurement of the

induced voltage. A new highly stable and programmable current source has been developed which combines a very low drift of less than 10^{-9}/min with very low noise.

The BIPM watt balance has been designed to carry out an original measurement mode, in which the measurements of the usually separated static and dynamic phases are carried out simultaneously, with the aim to eliminate the effects of temporal instabilities. In addition to this operation mode, the BIPM watt balance can be operated in the conventional two-phase mode. Comparison of the results obtained using both schemes will allow the search for systematic errors. The single-mode operation requires the separation of the induced voltage – needed for the measurement equation – from the resistive voltage. Several techniques have been applied to eliminate the resistive voltage drop. One technique uses a bifilar coil, where the current is sent through only one winding, but the induced voltage can be measured on both windings. The data obtained by this technique can be combined in two fundamentally different ways to obtain the value of the Planck constant, which again allows checking for systematic effects. A series of measurements showed that the relative difference between both measurement schemes is 2×10^{-7} with a relative uncertainty of 3×10^{-7}. Another technique to eliminate the resistive voltage, when using a monofilar coil, combines data obtained at the same vertical position in the air gap, with the coil travelling upwards and downwards. The results of the data-combination technique and the bifilar-coil technique have been compared and limitations of the data-combination technique have been demonstrated. As a consequence, the data-combination technique has been refined by including the effect of temperature changes.

Successive measurements of the Planck constant, obtained before the move to the new laboratory, showed a repeatability at the level of 1×10^{-6}. The repeatability is expected to improve in the new laboratory due to reduced ground vibration and better environmental conditions.

The development of the BIPM watt balance started with the idea of using a superconducting coil in a cryogenic magnet, an elegant way to eliminate the resistive voltage drop. At present the BIPM does not envisage building a cryogenic watt balance, but a feasibility study into this possibility was carried out by a research fellow between September 2009 to August 2011, and which has continued at a relatively low level of activity. A prototype of a superconducting moving coil watt balance has been built, which allows the behaviour of a superconducting coil moving relative to a magnetic field to be studied, as occurs in a real watt balance. Experiments using bifilar coils with normal and superconducting wire led to the conclusion that there is a clear difference in the behaviour of the superconducting coils above and below the transition temperature. The preliminary explanation is that the changing magnetic field leads to changing Meissner currents on the surface of the superconductor, which itself results in a varying magnetic field inducing voltages in adjacent wire turns. It is too early to draw any final conclusions about the feasibility of a superconducting watt balance.

2.5. Ionizing radiation

The former Director of the Ionizing Radiation Department, Dr P.J. Allisy-Roberts, retired on 31 May 2012 and the new Director, Mr J.M. Los Arcos, took over on 1 July 2012. The *ad interim* Director of the Ionizing Radiation Department was Dr D.T. Burns from 1 to 30 June 2012.

The Ionizing Radiation Department continues to develop standards for dosimetric measurements, specifically cavity ionization chambers for the new Theratron ^{60}Co beam and for the transportable calorimeter system. A thin-walled chamber with a waterproof exterior for the medium-energy absorbed-dose project and a primary standard was completed in 2012 for the ININ (Mexico).

A second graphite calorimeter core and jacket were fabricated to serve as both an independent verification and replacement in case of failure for the calorimeter-based BIPM.RI(I)-K6 comparisons in

accelerator beams, which serve to validate the NMI dose reference used in the calibration and audit services offered to hospitals. The second graphite calorimeter core and jacket agreed with the previous set within the statistical standard uncertainty of 0.17 %. The calorimetric absorbed-dose determination has a statistical standard uncertainty of 0.04 % and is around 0.1 % higher than the reference ionometric determination, well within the combined standard uncertainty.

Following the installation of the new Theratron irradiator in November 2011, the ^{60}Co source was finally installed in October 2012 following authorization delays. Characterization of the new reference beam is ongoing.

The project to develop an absorbed-dose standard for medium-energy x-rays has progressed and will continue into the programme of work 2013 to 2015. By Monte Carlo simulation of the x-ray tube arrangement and the BIPM method for measuring the mean air-attenuation coefficient, μ_a, it was determined that while the calculated μ-values for air and graphite are each lower than the corresponding measured values by 3 %, the calculated and measured ratios $\mu_{a,c}$ agree within the statistical standard uncertainty of 1 %, except at 100 kV where a difference of 4 % is evident. Although this is a positive result, there is at present no explanation for differences exceeding 5 % between the preliminary air-kerma rates determined using a thin-walled graphite cavity chamber and the reference values determined using the free-air chamber. These differences require further investigation.

Monte Carlo calculations have continued for the absorbed-dose conversion from graphite to water via a comparison with the LNE-LNHB (France), which showed consistent results with other NMIs and demonstrated the robustness of the BIPM dose-conversion procedure. Measurements and calculations of the BIPM ^{60}Co beam depth-dose distribution in water complemented the corresponding work carried out in 2011 in graphite and allowed a standard uncertainty of less than 0.1 % to be obtained for the ratio of photon attenuation coefficients in graphite and water.

The evaluation of the W_a-value for air and the I_c-value for graphite was published in *Metrologia* (2012, **49**(4), 507-512) and the conclusion is to change the recommended value for I_c from 78 eV to 81 eV (with standard uncertainty 2 eV) but to keep the present value for W_a of 33.97 eV increasing its uncertainty from 0.15 % to 0.32 %. This will have a significant impact on air-kerma determination using free-air chambers. This work will be incorporated into the International Commission on Radiation Units and Measurements (ICRU) Report on Key Data.

An analysis of the I-values for water was presented to the ICRU Report Committee including both measurements made over the past 40 years and values derived from theory, with uncertainty estimates sometimes unreliable or non-existent, and the recommended value I_w = 78 eV, with standard uncertainty 2 eV.

Primary measurements and reference chamber calibrations for NMIs have continued in all of the reference x- and gamma-ray beams, with a significant effort in equipment calibration and maintenance as required by the BIPM Quality Management System (QMS). A successful external audit was held in April 2012 and the procedures, technical instructions, forms and laboratory records were subsequently improved in response to the audit.

During 2012, eight comparisons were carried out: two air-kerma comparisons in the ^{60}Co and the ^{137}Cs beams with the NMIJ (Japan); four air-kerma comparisons in x-ray beams, with the VSL (Netherlands) at low energies and with the VSL, the International Atomic Energy Agency (IAEA) and the VNIIM (Russian Federation) in the mammography beams; and two high-energy absorbed-dose comparisons in the accelerator beams of the LNE-LNHB (France) and the ARPANSA (Australia). These on-site comparisons require a significant logistical effort, both to send the BIPM equipment in advance, and to perform the pre- and post-comparison verifications at the BIPM headquarters to ensure the reliability of measurements.

In addition, twenty-four characterizations of national standards were carried out: four in low-energy x-rays for the NIS (Egypt), ININ and the CMI (Czech Republic); three in mammography x-rays for the ININ and the CMI; three in medium-energy x-rays for the NIS, ININ and the CMI; eleven in ^{60}Co for the NIS, the METAS, the CMI, the BIM (Bulgaria) and the KRISS (Republic of Korea); and three in ^{137}Cs for the NIS, the CMI and the BIM.

The IAEA/World Health Organization (WHO) dosimetry assurance programme continues to be supported by biannual reference irradiations, which in 2012 involved one series of irradiations for radiotherapy level in the ^{60}Co beam and one for radiation-protection level in the ^{137}Cs beam.

Seven comparison reports were published in the *Metrologia Technical Supplement* in 2012, two reports for the ARPANSA (Australia) and one each for the GUM (Poland), the MKEH (Hungary), the NIST, the NPL and the VNIIM. In addition, the report '*A blind test of the alanine dosimetry secondary standard of the PTB conducted by the BIPM*' has been submitted to *Metrologia*.

In 2012, as part of the radionuclide measurements programme, the International Reference System (SIR) received nine ampoules filled with six different radionuclides from six laboratories, containing ^{59}Fe (PTB), ^{60}Co (BARC and NRC), ^{109}Cd (LNE-LNHB), ^{131}I (LNE-LNHB and NIST), ^{133}Ba (BEV and LNE-LNHB) and ^{222}Rn (LNE-LNHB), to generate equivalence values in the ongoing BIPM.RI(II) K1 key comparison. The reporting forms for four previous submissions, ^{60}Co, ^{152}Eu and ^{241}Am from the CNEA (Argentina) and ^{64}Cu from the ENEA (Italy), were received in 2012 and the corresponding SIR results have been evaluated. Routine measurements of potential impurities in SIR ampoules are made using the Ge(Li) and HPGe spectrometers. No impurity was detected in the ^{131}I and ^{109}Cd solutions submitted to the SIR by the LNE-LNHB and the NIST.

All SIR measurements are covered by the BIPM Quality Management System and a successful external audit, which for the first time included the extension to short-lived radionuclides, was carried out on 21 September 2012 by Prof. Dr F.O. Bochud, the IRA (Switzerland). In response, several procedures are being revised and improved.

The BIPM.RI(II)-K4.Tc-99m key comparison of short-lived radionuclides using the SIR Transfer Instrument (SIRTI) is now running at a rate of two comparisons per year: the NIM (China) and the CNEA (Argentina) participated in 2012 and the LNMRI (Brazil), the IFIN-HH (Romania), the VNIIM and the NMISA (South Africa) are the next planned participants. A copy of the SIRTI electronics was updated and a backup copy of the SIRTI detector has been purchased and is being characterized before calibration against the SIR.

The extension of the SIRTI for measuring ^{18}F is in development. Test measurements are in progress before calibration against the SIR. The NIST has already volunteered to participate together with the ENEA, which will immediately participate in the ^{99m}Tc and ^{18}F comparisons.

As part of the comparison organized by the CCRI(II) Working Group on the Extension of the SIR (ESWG) to the measurement of pure beta emitters, the BIPM received a further ampoule of ^{63}Ni prepared by the NPL in 2012 to complete those previously sent by seven laboratories: the ENEA, the IRMM (EU), the LNE-LNHB, the NIST, the NMISA, the PTB and the POLATOM RC (Poland). Sets of samples were prepared in three different scintillators and were measured in the Beckman LS spectrometer, using the method based on the universal cross-efficiency curves, and in the Triple-to-Double Coincidence Ratio Technique (TDCR) spectrometer, using the apparent activity method for which the analysis of results continues. The results will be presented at the next ESWG meeting at the BIPM headquarters in May 2013 and at the 19th International Conference on Radionuclide Metrology and its Applications (ICRM 2013) to be held in Antwerp, Belgium, on 17 to 21 June 2013.

The BIPM participated in the CCRI(II)-K2.Tc-99 activity comparison organized and piloted by the NPL in 2012. After several postponements, the participants have agreed a definitive deadline of February 2013

for contributions. The BIPM participated in the activity comparison of this long-lived ($T_{1/2}$ = 211.5 ×10^3 a, u = 1.1 × 10^3 a) almost pure beta emitter. Only the second order transition to the ground state with an end-point energy of 293.6 keV, u = 1.8 keV was considered in this study, since the emission probabilities of another beta transition and a gamma emission are much lower. Several sets of samples were prepared in three commercial scintillators (Ultima Gold, Hionic Fluor and Bio-Fluor +) and measured with the commercial liquid-scintillation Beckman spectrometer and the TDCR instrument which was developed by the BIPM. The BIPM will take advantage of the postponement of the deadline to evaluate the data obtained with the TDCR spectrometer.

Updated reports of four comparisons were published in the *Metrologia Technical Supplement* series covering ^{222}Rn, ^{57}Co, ^{241}Pu and ^{99m}Tc. The comparison results are now communicated by the participants using the new Excel-based reporting forms developed by the BIPM. The use of these forms and the corresponding KCsoft software, also developed by the BIPM, helped to speed up the publication process. Every result prior to 2008 has been published in the *Metrologia Technical Supplement* except for two which are in preparation. There are three outstanding results from 2008 pending publication, one of which is in circulation. To date, all the Draft A reports have been submitted except for three results that are still awaited from the NMIs concerned.

The Ionizing Radiation Department provides internal calibration services for thermometry at the BIPM. In 2012, 18 standard platinum resistance thermometers (SPRTs) and 9 commercial laboratory thermometers belonging to the Chemistry, Electricity, Mass, Time and Ionizing Radiation Departments were calibrated. An external audit was carried out in May 2012 and the recommendation was made that the BIPM should participate in key comparisons of fixed points or SPRTs. In June 2012, the BIPM was invited by the CCT to take part in the CCT-K9 comparison, which is already under way and piloted by the NIST. For this purpose, comparison measurements were carried out at the BIPM during September 2012 and two BIPM SPRTs were hand-carried to the NIST at the end of September for subsequent measurement.

2.6. Chemistry

The Chemistry Department continues to make significant progress in its three core areas of activity: international comparisons and equivalence of gas standards for air quality and climate change monitoring; the international comparison programme on primary organic calibrators; and by providing support for the Consultative Committee for Amount of Substance: Metrology in Chemistry (CCQM), JCTLM activities and liaison with intergovernmental organizations.

In the area of Gas Metrology, the BIPM coordinates Surface Ozone reference standard comparisons (BIPM.QM-K1) with seven laboratories participating in comparisons at the BIPM, and one further laboratory receiving a calibration in 2012. Development of a laser-based standard reference photometer (SRP) and ozone absorption cross-section measurements continues, with a publication in the *Journal of Geophysical Research* [*] on new relative measurements, and progress in the production and characterization of pure ozone studied with the assistance of a visiting scientist from the GUM (Poland) for six months. Final reports of the CCQM-K74 and CCQM-P110.B1 comparisons for nitrogen dioxide standards have been published, and a paper describing the operation and validation of the BIPM NO_2 primary facility used for the key comparison reference value was published in *Analytical Chemistry*[†]. The validation of BIPM facilities for the coordination of CCQM-K82 on methane at ambient levels has been completed, and measurements will begin at the BIPM when all gas standards from participating

[*] M. Petersen, J. Viallon, P. Moussay, and R. I. Wielgosz (2012), Relative measurements of ozone absorption cross-sections at three wavelengths in the Hartley band using a well-defined UV laser beam, *J. Geophys. Res.*, *117*, D05301, doi:10.1029/2011JD016374

[†] E. Flores, F. Idrees, P. Moussay, J. Viallon, R. Wielgosz. Highly accurate nitrogen dioxide (NO_2) in nitrogen standards based on permeation. *Anal. Chem.*, 2012, 84 (23), 10283–10290, DOI: 10.1021/ac3024153

NMIs have been delivered. Preparatory work for the coordination of CCQM-K90 on formaldehyde (HCHO) in nitrogen standards continued, with stability and purity tests being performed on a new set of cylinders.

The BIPM's organic programme forms an essential and integral part of the CCQM Working Group on Organic Analysis (OAWG) strategy for Core Competency comparisons. The BIPM has an ongoing role as the coordinating laboratory for comparisons (CCQM-K55 series) of NMI capabilities for primary calibrator characterization, which is the basis of all traceability claims for NMI capabilities in organic analysis. Final reports for the CCQM-K55.a (Estradiol) and CCQM-K55.b (Aldrin) comparisons were approved for equivalence and published in the BIPM KCDB. The CCQM-K55.c [(L)-Valine] key comparison and the parallel CCQM-P117.c pilot study were coordinated by the BIPM Chemistry Department. Twenty institutes submitted results for the key comparison and ten institutes for the parallel pilot study. The results of the comparisons were submitted to the BIPM in October 2012, and a summary of results was prepared and discussed at the CCQM OAWG meeting held in Hong Kong in November 2012. A paper describing the BIPM implementation of the mass balance method for determining the mass fraction of the main component of a high purity organic material has been drafted and submitted to *Analytical Chemistry*.

The Chemistry Department has made progress in the investigation of pure material characterization methods for organic analytes of higher molecular weight and complexity that are of direct relevance to the CCQM and its key comparison programme. Mass balance methods for the mole fraction purity determination of Angiotensin I, aided by collaboration with the NIST, have been completed. Amino acid analysis methods for purity determination are currently under development and validation, and will also be applied to a second model material (insulin). A two-year visiting scientist secondment from NIM (China) has been agreed and will start in 2013. The secondment will enable the NIM and the BIPM to coordinate a CCQM large organic molecule primary calibrator comparison during 2014 to 2015.

For information about the Joint Committee for Traceability in Laboratory Medicine (JCTLM) see §4.3.2.

2.7. Comparisons

During 2012, there were a total of 34 comparisons coordinated by the BIPM involving 232 NMI participations.

2.7.1. Mass

Mass Department key comparison (CCM-M-K4): Measurements were completed in 2012 and the Draft A report is in preparation.

Comparison	Description	No. of NMI Participations
CCM.M-K4	Comparison of mass standards	16

2.7.2. Time

The Time Department pilots the key comparison CCTF-K001.UTC, published through the monthly *Circular T*. In 2012, 12 key comparisons (one each month) were carried out with 72 participants.

Comparison	Description	No. of NMI Participations
CCTF-K001.UTC	Calculation of the reference time scale UTC	72

2.7.3. Electricity

In 2012 the Electricity Department organized four ongoing bilateral comparisons with seven NMI participations. Resistance comparisons, BIPM.EM-K13, with two additional NMIs had to be postponed due to problems with the air conditioning. The on-site comparison of quantum Hall resistance standards, BIPM.EM-K12, has been inactive for several years but, following a request by the CCEM, preparations are under way to resume the comparison in 2013. The Department participates in the EURAMET supplementary comparison EURAMET.EM-S31 (capacitance at 10 pF and 100 pF) and in APMP.EM.BIPM-K11.3 (Zener voltage at 1.018 V and 10 V), to link it with the Zener voltage comparisons of other Regional Metrology Organizations (RMOs).

Comparison	Description	No. of NMI Participations
BIPM.EM-K10	DC voltage, Josephson standards: (a) 1.018 V; (b) 10 V	2
BIPM.EM-K11	DC voltage, Zener diode: (a) 1.018 V; (b) 10 V	1
BIPM.EM-K12	Quantum Hall resistance standards and their scaling to other resistance values	0
BIPM.EM-K13	Comparison of resistance standards: (a) 1 ; (b) 10 k	2
BIPM.EM-K14	Comparison of capacitors: (a) 10 pF; (b) 100 pF	2
	Total	**7**

2.7.4. Ionizing Radiation

In 2012 the Ionizing Radiation Department undertook 16 bilateral comparisons for the ongoing comparisons it conducts. In addition, the Department piloted (with the CIEMAT) the Trial Exercise for Ni-63 within the CCRI(II) Extension of SIR Working Group CCRI(II), and participated in the CCRI(II)-K2.Tc-99 comparison (pilot: NPL).

Comparison	Description	No. of NMI Participations
BIPM.RI(I)-K1	Measurement of air kerma for Co-60 gamma-rays	1
BIPM.RI(I)-K2	Measurement of air kerma for low energy x-rays	1
BIPM.RI(I)-K5	Measurement of air kerma for Cs-137 gamma-rays	1
BIPM.RI(I)-K6	Measurement of absorbed dose to water for high-energy beams	2 (off-site, LNHB, ARPANSA)
BIPM.RI(I)-K7	Measurement of air kerma for mammography beams	3
BIPM.RI(II)-K1.Fe-59	Activity of radionuclides	1
BIPM.RI(II)-K1.Co-60	Activity of radionuclides	1
BIPM.RI(II)-K1.Cd-109	Activity of radionuclides	1
BIPM.RI(II)-K1.I-131	Activity of radionuclides	1
BIPM.RI(II)-K1.Ba-133	Activity of radionuclides	1
BIPM.RI(II)-K1.Rn-222	Activity of radionuclides	1
BIPM.RI(II)-K4.Tc-99m	Activity of radionuclides	2 (off-site, NIM, CNEA)
ESWG(II)-Ni-63 (extension of SIR)	Trial Exercise within the CCRI(II) Extension of SIR Working Group (Pilot: BIPM and CIEMAT)	9
CCRI(II)-K2.Tc-99	Activity concentration of the same Tc-99 solution 2012 – 2013 (Pilot: NPL)	10
	Total	**25**

2.7.5. Chemistry

In 2012 the Chemistry Department worked on five key comparisons and five pilot studies (all coordinated by the BIPM).

The Chemistry Department also undertook preparatory/validation work for three more comparisons which are planned for 2013/2014.

BIPM coordinated comparisons for which measurements have started or are completed:

Comparison	Description	Activity in 2012	No. of NMI participations
BIPM.QM-K1	Ozone ambient level	Measurements completed and reports published	7
CCQM-K55.c	Purity analysis series: L-Valine	Measurements completed	19
CCQM-P117c			10
CCQM-K74	Nitrogen dioxide 10 µmol/mol	Published in the BIPM KCDB	16
CCQM-P110-B1	Nitrogen dioxide 10 µmol/mol: spectroscopic study	Published in *Metrologia* Technical Supplement	10
CCQM-P110-B2	Nitrogen dioxide 10 µmol/mol: spectroscopic study	Final report being finalized	9
CCQM-K55.a	Purity analysis series: 17β-Estradiol	Published in the BIPM KCDB	11
CCQM-P117a	Estradiol: purity	Report completed	8
CCQM-K55.b	Purity analysis series: Aldrin	Published in the BIPM KCDB	18
CCQM-P117b	Aldrin: purity	Report circulated	4
		Total	**112**

BIPM coordinated comparisons for which preparatory/validation work has started:

Comparison	Description	Activity in 2012	No. of NMI participations
CCQM-K82	Methane in air (ambient)	Awaiting arrival of standards from NMIs for measurements to begin	16
CCQM-K90	Formaldehyde in nitrogen	Stability studies of transfer standards	
CCQM-K55.d	Purity analysis series: Folic Acid	Specification of comparison material	

2.8. Calibrations

In the period from 1 January 2012 to 31 December 2012, 88 Certificates and 4 Study Notes were issued. A complete list of certificates is provided in Appendix 2.

3. THE CIPM MRA

3.1. New signatories to the CIPM MRA

The following institutions signed the CIPM MRA during 2012:

- Botswana Bureau of Standards (BOBS) on 26 July 2012;
- National Standards Calibration Laboratory (NSCL), Syrian Arab Republic on 17 September 2012;
- European Space Agency (ESA) on 8 October 2012;
- Namibian Standards Institution (NSI) on 16 October 2012.

3.2. The BIPM key comparison database (KCDB)

Biannual reports on KCDB work are available on the BIPM website at http://www.bipm.org/jsp/en/ViewKCDBReport.jsp. Readers are encouraged to consult these documents for detailed information concerning publication of key and supplementary comparisons and of approved sets of Calibration and Measurement Capabilities (CMCs).

As of 19 November 2012, the key and supplementary comparisons database contained 819 key comparisons (86 from the BIPM, 405 from the CCs, and 328 from the RMOs) and 328 supplementary comparisons. Of the 819 key comparisons registered:

- 88 corresponded to exercises carried out prior to the entry into force of the CIPM MRA, and which therefore will never have results published in the KCDB; they have been 'Approved for provisional equivalence'.
- 74 of the 84 ongoing BIPM key comparisons had results published in the KCDB.
- a further 394 CC and RMO key comparisons had their final reports approved and were posted on the KCDB website, with corresponding tables of numbers and graphs entered in the database.

On 19 November 2012, 1 920 graphs of equivalence were displayed in the KCDB.

Fifty new key comparisons and 43 new supplementary comparisons were registered in 2012, a much higher registration rate than observed in previous years. This may be due to the organization of regional exercises by NMIs from new Associates of the CGPM.

Updated graphs illustrating participation in key and supplementary comparisons were made available on the statistics page of the KCDB on 20 November 2012.

The results of 168 RMO key comparisons (59 conducted by the Asia Pacific Metrology Programme (APMP), 19 by the Euro-Asian Cooperation of National Metrology Institutions (COOMET), 74 by the EURAMET, and 16 by the SIM) were published in the KCDB, and linkage has been carried out for 50 bilateral key comparisons subsequent to full-scale CC key comparisons; the results are included in the appropriate graphs of equivalence.

April 2012 saw the successful linkage of a family of nine key comparisons: M.M-K1 (1 kg stainless steel standards), that includes 89 degrees of equivalence relative to the CCM.M-K1 key comparison reference value. These results span more than 15 years and a new central CIPM key comparison, CCM.M-K4, has been launched with the BIPM acting as the pilot laboratory, thus restarting the whole exercise. Other examples that gather together seven or eight linked key comparisons can be found in the KCDB.

Final reports for 183 of the 328 supplementary comparisons registered in the KCDB have been posted as

of 19 November 2012.

Altogether 65 % of the comparisons registered in the KCDB are complete. The final reports have been posted in the KCDB and are generally published in the *Metrologia Technical Supplement*. This percentage has been stable over several years.

On 19 November 2012, the KCDB included a total of 25 339 CMCs: 16 077 in General Physics, 3 902 in Ionizing Radiation, and 5 360 in Chemistry. Since 1 January 2012, 37 newly approved sets of CMCs have been published, which is equivalent to an additional 1 100 CMCs. A proportion (42 %) of the published CMCs had already been posted in the KCDB at the end of 2004, and on average some 1 900 new and revised CMCs have been approved annually between 2005 and 2011, with a similar number of approvals predicted for 2012.

A first set of CMCs declared by Bosnia and Herzegovina (7 CMCs in the field of Mass Standards) was posted in the KCDB on 8 June 2012, only one year after the Institute of Metrology of Bosnia and Herzegovina (IMBIH) signed the CIPM MRA.

All of the Associates which participate in the CIPM MRA had at least one of their metrology institutes listed as a participant in a key or a supplementary comparison as of 19 November 2012, yet only 15 of the 36 Associates currently have CMCs published in the KCDB; an indication of the effort involved to successfully complete the whole CIPM MRA scheme.

As of 19 November 2012, 251 CMCs had been temporarily removed from the KCDB, a number considered negligible when compared to the total number of CMCs contained in the KCDB. The KCDB office also dealt with numerous corrections, namely editorial changes, deletion of services that are no longer available, and changes in laboratory names and acronyms. In July 2012 the KCDB office divided the Excel CMC files made available on the JCRB CMC website - by category within the areas of Mass, Ionizing Radiation, Length, and Acoustics, Ultrasound and Vibration - for use in the CMC declaration and review process.

Details of the number of CMCs currently published in the KCDB, by country and by metrology area, and the situation concerning greyed-out CMCs, is available from the statistics page of the KCDB. An Excel file which records the history of CMC publications (including greying-out and reinstatement) is available on a restricted-access section of the JCRB CMC website. The dates of greying-out of CMCs are included in this file following a request by the JCRB at its 24th meeting (2010).

The log-on statistics for the period January to December 2011 showed the average number of monthly visits to the KCDB website were 7 800 and the average number of KCDB web pages opened each month were 110 000. The corresponding numbers for the period January to October 2012 were 9 300 and 140 000 respectively. The KCDB website continues to attract key communities: NMIs, regulators, accreditors, commercial and industrial companies.

The series of KCDB Newsletters ceased publication with Issue 16 dated 15 December 2011. News from the KCDB and the JCRB are now published in *BIPM e-News*. (see §8).

3.3. Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB)

Two meetings of the JCRB were held in 2012:

- The 28th meeting of the JCRB was held at the BIPM headquarters on 3 to 4 April 2012;
- The 29th meeting of the JCRB was held in Gaithersburg, Maryland, USA, on 25 to 26 September 2012.

The JCRB has confirmed that a one and half day workshop on 'Best Practices in CMC Reviews' will be held at the BIPM headquarters on 18 to 19 March 2013, immediately before the 30th meeting of the JCRB. The workshop will feature presentations by representatives of RMOs and Consultative Committees on the practices they have adopted to increase the effectiveness and efficiency of intra- and inter-RMO CMC reviews followed by a discussion on all aspects of the process. It is expected that the outcome of the workshop will be a series of recommendations for the improvement of the CMC review process.

The JCRB has adopted two resolutions clarifying the requirements for designated institutes participating in the CIPM MRA. JCRB Resolution 28/1 states that laboratories should only be designated under the CIPM MRA when they have responsibility for national measurement standards and the dissemination of the units, as demonstrated by provision of appropriate and relevant services to customers. JCRB Resolution 28/2 requires that the quality management system that is implemented prior to publication of CMCs in the KCDB should meet ISO/IEC 17025 (ISO 34 for CRMs[‡]) requirements for calibration laboratories.

GULFMET, an association of the NMIs of Kuwait, Qatar, Bahrain, United Arab Emirates, Oman, Yemen, and Saudi Arabia, submitted an application to join the JCRB as a new RMO. The application was discussed at the JCRB and it was agreed that while GULFMET did not fully meet the criteria for participation in the JCRB at present, there was the prospect that it may be able to do so in the future given continued engagement with the JCRB and the international metrology community and further accumulation of expertise. A delegation from GULFMET attended the 29th meeting of the JCRB as guests.

4. INTERGOVERNMENTAL AND INTERNATIONAL ACTIVITIES AND PROMOTION OF THE METRE CONVENTION

4.1. New States Parties to the Metre Convention (Member States) and new Associates of the CGPM (Associates) in 2012

At the end of 2012, there were 54 States Parties to the Metre Convention and 37 Associates of the CGPM.

The Republic of Tunisia acceded to the Metre Convention on 1 February 2012. In addition, four States became Associates of the CGPM in 2012: The Sultanate of Oman on 8 May 2012; The Republic of Botswana on 30 May 2012; The Syrian Arab Republic on 31 May 2012; and The Republic of Namibia on 10 August 2012.

The Republic of Cameroon and the Democratic People's Republic of Korea were excluded in 2012 after having been in financial arrears for more than six years and failing to enter into a rescheduling agreement with the CIPM (see Resolution 6 and Resolution 7 of the 24th meeting of the CGPM (2011)).

4.2. Institutional collaboration with external organizations

The International Liaison and Communication Department of the BIPM has the role of promoting metrology to the scientific community, industry and the public. It undertakes this role in a number of

[‡] Certified reference materials

ways through liaison activities with other intergovernmental organizations and international bodies and by participation in international forums. The BIPM has an ongoing relationship and significant interaction with more than thirty international organizations and provides or shares information with these bodies relating to the SI and the international comparability of measurements. Collaborations are both institutional and technical and in 2012, a typical year, BIPM staff travelled on around 120 separate occasions, amounting to more than one person year of time, to provide their expertise on this activity. Additionally, the BIPM participated in one off initiatives organized by half a dozen or so intergovernmental organizations and international bodies.

Key liaison activities are with intergovernmental organizations such as the WHO, the IAEA, the WMO, the International Organization of Legal Metrology (OIML) and international bodies such as the International Organization for Standardization (ISO) and the International Laboratory Accreditation Cooperation (ILAC). Interaction varies from high-level discussions to participation in dedicated working groups but the objective remains the same: promoting the importance and appropriate use of metrology and the international infrastructure.

Notable achievements in 2012 were:

- The signing of a new Memorandum of Understanding (MoU) in March 2012 between the CIPM and the ILAC, reaffirming the continued need to strengthen the links between accreditation and metrology and to coordinate their activities related to national and international measurement infrastructure. The BIPM and the ILAC collaborated throughout 2012 on a number of technical matters related to the development of ILAC policy documents.
- The publication of a 'Joint ILAC – CIPM Communication regarding the Accreditation of Calibration and Measurement Services of National Metrology Institutes' in March 2012. NMIs are not required to be accredited to participate in the CIPM MRA but, for a variety of reasons, many choose to have their services accredited. The joint communication provides guidance which will help optimize the processes to avoid unnecessary duplication when an NMI is undergoing both the evaluation of CMCs in the CIPM MRA and the accreditation of its measurement services.
- The appointment of Dr Estefanía de Mirandés (BIPM Mass Department) as a member of the Committee on Data for Science and Technology (CODATA) Task Group on Fundamental Constants in April 2012. The purpose of the Task Group is to periodically provide the scientific and technological communities with a self-consistent set of internationally recommended values of the basic constants and conversion factors of physics and chemistry based on all of the relevant data available at a given point in time.
- The election of Dr David Burns (BIPM Ionizing Radiation Department) as a Commissioner of the ICRU. The ICRU mission is to develop and promulgate internationally accepted recommendations on radiation-related quantities and units, terminology, measurement procedures, and reference data for the safe and efficient application of ionizing radiation to medical diagnosis and therapy, radiation science and technology, and radiation protection of individuals and populations.
- World Metrology Day is an annual event staged on 20 May which celebrates the signing of the Metre Convention in 1875. The theme in 2012 was 'Metrology for Safety' - a wide-ranging topic but one which concerns everyone in a multitude of situations. World Metrology Day is jointly delivered by the BIPM and the OIML, involving a dedicated website http://www.worldmetrologyday.org with a poster, press release and message from the Directors of the BIPM and the International Bureau of Legal Metrology (BIML) as well as events organized by NMIs to raise awareness of metrology. The BIPM and BIML also collaborate on a number of institutional and technical matters throughout the year.

- The conclusion of an MoU between the BIPM and the IAEA in June 2012, formalizing more than 50 years of close working relations between the two organizations in the field of radiation measurements. The signing of the MoU marked a step towards new pathways for the future following collaborations that have existed since 1959 between the IAEA and the CIPM Consultative Committee for Ionizing Radiation (CCRI). The BIPM Ionizing Radiation Department has worked closely with the IAEA Dosimetry and Medical Radiation Physics Group in the intervening years to provide reference dosimetry and support for the WHO/IAEA Secondary Standards Dosimetry Laboratory (SSDL) Network programme. More recently the collaborations have involved comparisons of reference materials and similar work is planned for future collaborations.
- The European Space Agency (ESA) became a signatory of the CIPM MRA on 8 October 2012. The ESA operates a time laboratory that seeks to maintain a time scale directly traceable to UTC. Linking ESA's Galileo global satellite navigation system to UTC will potentially allow future GPS receivers to access more than one global satellite navigation system providing greater reliability and accuracy.
- The publication of JCGM 106:2012 'Evaluation of measurement data – The role of measurement uncertainty in conformity assessment' in October 2012. It constitutes the fourth of the series of documents accompanying the 'Guide to the Expression of Uncertainty in Measurement' (GUM). JCGM106:2012 was developed by the Working Group on the Expression of Uncertainty in Measurement (JCGM-WG1).
- Ongoing collaboration with the WMO through a joint liaison group (JLG). The long-term aim of the JLG is to bring together the combined expertise of the metrology and meteorological communities to reduce measurement uncertainty for the 50 Essential Climate Variables (ECVs).

4.3. Joint Committees

4.3.1. Joint Committee for Guides in Metrology (JCGM)

The representatives of the eight member organizations of the JCGM met at the BIPM headquarters on 5 December 2012 for its annual plenary session. Reports of its Working Groups (WG1 on the Guide to the Expression of Uncertainty in Measurement (GUM) and WG2 on the International Vocabulary of Metrology (VIM)) were presented.

- The main effort of WG1 is on the revision of the GUM (Document JCGM 100). In this respect, an online survey was conducted, which gave reassuring results. Document JCGM 106:2012, '*Evaluation of measurement data - The role of measurement uncertainty in conformity assessment*' was approved and published in October 2012. A reply to the International Union of Pure and Applied Chemistry (IUPAC) concerning the way in which uncertainties are assigned to the atomic weights of some elements is being discussed and will be sent in the near future.
- WG2 has undertaken four projects in 2012 that are designed to address user concerns expressed about the complexity of the VIM3: 1) An online survey was conducted, providing many useful comments on VIM3; the analysis of the responses were, overall, more supportive than negative, but with a clear support for an 'easier to understand' version of the VIM3; 2) An initial set of Frequently Asked Questions (FAQs) about the VIM3 has been developed (in both English and French) and is available on the BIPM website; 3) A set of articles that provide Rationale for the VIM3 has been compiled; and 4) A proposal for a new WG2 work project to develop an annotated version of the VIM3 has been drafted.

At its December 2012 meeting the JCGM formally asked the WG2 to produce a set of annotations to VIM3 for presentation at the next meeting of the JCGM in 2013. Consensus was reached that annotations to VIM3 will be informative and not normative, and therefore will not require full approval.

The JCGM also discussed the need for a general vocabulary on nominal properties. In this regard, it recommends that the IUPAC and the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) reconsider the title of their document '*Vocabulary for nominal properties and nominal examinations – Basic and general concepts and associated terms*' in order to reflect the specific aspect related to clinical chemistry that this document deals with. It then tasked WG2 to develop a paper that explores the feasibility for it to develop an international vocabulary on nominal properties, and further explores various issues associated with merging or not merging such a vocabulary with a future edition of the VIM.

4.3.2. Joint Committee for Traceability in Laboratory Medicine (JCTLM)

The annual joint meeting of the JCTLM Working Groups 1 and 2, and a*d hoc* Working Group 3 was held in conjunction with the American Association for Clinical Chemistry (AACC) meetings in Los Angeles, USA, in July 2012. This was followed by a workshop on 'JCTLM reference measurement systems for HbA1c', and a joint JCTLM and *in vitro* diagnostic (IVD) industry workshop on 'Meeting traceability requirements for the IVD industry'. The 11th meeting of the Executive Committee of the JCTLM was held at the BIPM headquarters on 6 to 7 December 2012.

The list of JCTLM review teams in Working Group 1 and 2 was updated to include the review team member appointed for the review of nominations for drugs. The document for the terms of reference for each review team was revised for harmonization by the Quality Review team leader and finalized after review by WG1 review teams. The Executive Committee procedure for the selection and appointment of Working Group review team leaders and members was updated to include the term of membership which is five years renewable.

WG2 procedures have been updated to include a requirement for consistency of the expanded uncertainty ranges in the database in line with those stated in the reference measurement service providers' scope of accreditation.

The JCTLM Database was updated in January 2012 to remove temporary reference measurement services from laboratories undergoing the accreditation process after the accreditation deadline for compliance with ISO 15195 and ISO/IEC 17025 as Calibration laboratory. In March 2012, the WG1 Cycle 8 reference materials, and measurement methods, and WG2 Cycle 7 reference measurement laboratory services approved by the Executive Committee during its 10th annual meeting in December 2011 were published in the database.

As of December 2012 the JCTLM Database contained:

- 262 available certified reference materials covering 11 categories of analytes. Of these reference materials, 33 are in List II, which includes reference materials value-assigned using internationally agreed protocols, and three are in List III, which covers reference materials with nominal properties;
- 157 reference measurement methods or procedures that represent about 80 different analytes in eight categories of analytes;
- 74 reference measurement services, delivered by eight reference laboratories and one NMI in five countries and which cover six categories of analytes.

The WG1 Cycle 9 call for nominations of higher order reference materials and reference measurement methods or procedures, and the WG2 Cycle 7 call for nominations of reference measurement laboratory

services were announced on the JCTLM website in January 2012, and email notifications were sent to about 300 JCTLM potential contributors. As of July 2012, 42 nominations for materials, two nominations for methods, and six nominations for services had been received and sent to Review Teams for evaluation.

4.4. Scientific liaison with intergovernmental organizations and international bodies

4.4.1. Director's Office

M. Kühne is a member of the German Physical Society (DPG) and a Fellow of the Institute of Physics (IoP), UK. He is an adjunct Professor at the Faculty of Mathematics and Physics of Leibniz Universität Hannover, Germany. As Director of the BIPM, M. Kühne is Chairman of the JCRB and the JCGM.

M. Milton is a Fellow of the Institute of Physics (IoP) in the UK.

4.4.2. International Liaison and Communication

A. Henson is the BIPM liaison with ILAC and participates in the ILAC Accreditation Issues Committee (AIC) and AIC WG2 on matters related to calibration and traceability. He is the BIPM Representative to the NCSLI Board of Directors and the BIPM liaison in the WMO-BIPM Joint Liaison Group. He has general responsibility for the institutional relationships maintained by the BIPM with approximately 30 intergovernmental organizations and international bodies.

C. Thomas acts as the Scientific Secretary and is a member of the permanent Committee "*Science et métrologie*" of the French *Académie des Sciences*. She is a member of the JCGM WG2 and the Organizing Committee and the Technical and Scientific Committee of the 16th International Congress of Metrology, to be held in Paris in October 2013. C. Thomas acts as the BIPM Liaison for the CODATA Task group on Fundamental Constants and for the ISO TC 12 "Quantities and Units", and also as the BIPM Contact and *rapporteur* for the JCGM and its WG2 (VIM).

4.4.3. Mass

A. Picard acts as the BIPM liaison with the International Avogadro Coordination (IAC) project, IMEKO Technical Committee 3 (TC3) and EURAMET Technical Committee of Mass and Related Quantities (TC-M) and Technical Committee of Thermometry (TC-T).

A. Picard is coordinator for mass measurements in the former International Avogadro Coordination project/CCM Working Group on the Avogadro Constant (WGAC).

A. Picard is the contact person for the European Metrology Research Programme (EMRP) joint research project SIB-05 (NewKilo) and SIB-03 (kNOW).

4.4.4. Time

E.F. Arias is a member of the International Astronomical Union (IAU) and participates in its working group on the International Celestial Reference System, she co-chairs the working group on the redefinition of UTC. She is an associate member of the International Earth Rotation Service (IERS), a member of its International Celestial Reference System Centre, and of the Conventions Centre of the IERS. She is a member of the International VLBI Service (IVS), and of its Analysis Working Group on

the International Celestial Reference Frame. She is the BIPM representative to the Governing Board of the International GNSS Service (IGS). E.F. Arias is the BIPM representative to the International Committee on GNSS (ICG) and she is the chairperson of the Task Force on Time References. She is a member of the Global Geodetic Observing System (GGOS) Steering Committee representing the BIPM. She is a member of the Argentine Council of Research (CONICET) and an associated astronomer at the LNE-SYRTE, Paris Observatory. She is a corresponding member of the *Bureau des longitudes*. She is the BIPM representative to the Working Party 7A of the Study Group 7 of the International Telecommunication Union – Radiocommunication Sector (ITU-R).

W. Lewandowski is the BIPM representative to the Civil GPS Service Interface Committee and chairman of its Timing Sub-Committee. He is a member of the Scientific Council of the Space Research Centre of the Polish Academy of Sciences. He is also a member of a consultative Group on the Reform of Metrology at the Polish Ministry of Economy, an adviser to a Parliamentary Group on Space, and a member of the Committee on Research on Space Techniques of the Polish Academy of Sciences. He is a member of the European Commission Advisory Group on Galileo Time Infrastructure. He is the BIPM representative to the Working Party 7A of the Study Group 7 of the ITU-R, and the ICG.

G. Petit is co-director of the Conventions Centre of the IERS. He is president of the IAU Commission 52 'Relativity in Fundamental Astronomy', member of the IAU Working Group on Numerical Standards in Fundamental Astronomy, of the International GNSS Service (IGS) Working Group on Clock Products, of the GNSS Science Advisory Committee of the ESA, and of the Fundamental Physics Group of the CNES.

4.4.5. Electricity

M. Stock is a member of the Conference on Precision Electromagnetic Measurements (CPEM) Executive Committee. M. Stock and N. Fletcher are members of the Technical Committee of CPEM 2012. M. Stock is a member of the Scientific Committee for the 4th International Conference on Quantum Metrology (QM2013), to be held in Poznan, Poland, on 15 to 17 May 2013.

M. Stock is the contact person for the BIPM liaison with the International Commission on Illumination (CIE). A joint CCPR-CIE workshop was held on 22 February 2012 to coordinate the work between both organizations on the future *mise en pratique* for the definition of the candela.

N. Fletcher represents the BIPM on the 'Stakeholder Committee' for the EMRP Project GraphOhm (funded to start in July 2013).

4.4.6. Ionizing Radiation

J.M. Los Arcos evaluates scientific projects for the Spanish National Evaluation and Foresight Agency (ANEP). He is a technical auditor for the Spanish Accreditation Body and a referee for the journal *Applied Radiation and Isotopes*.

D.T. Burns is a Fellow of the Institute of Physics (FInstP) in the UK and in 2012 was elected as a Commissioner of the ICRU. He is a member of the ICRU Committee on Fundamental Quantities and Units and of two ICRU Report Committees (on Key Data for Dosimetry and on Operational Quantities for Radiation Protection). He is also Commission Sponsor for two reports (Key Data for Dosimetry and Small and Non-Standard Fields) and is the BIPM contact person for the EURAMET-TC for ionizing radiation (replaced by S. Picard at the 2012 meeting).

C. Michotte is the contact person at the BIPM and *rapporteur* for the JCGM WG1 that met in June and November 2012.

G. Ratel is the BIPM representative on the International Committee for Radionuclide Metrology (ICRM) and is the President of the ICRM Nominating Committee. He is also a member of the Scientific Committee for the 19th International Conference on Radionuclide Metrology and its Applications (ICRM 2013) which will be held in Antwerp, Belgium, on 17 to 21 June 2013.

P.J. Allisy-Roberts, who retired as Director of the Ionizing Radiation Department on 31 May 2012, has been the BIPM representative on the IAEA SSDL Scientific Committee which she currently chairs. She is a member of the Working Group for the UK National Measurement System (NMS) Programme for Ionizing Radiation and Acoustics and of the *Comité scientifique rayonnements ionisants* (LNE, France). She is a member of the editorial board of the *Journal of Radiological Protection* and of the *Revue Française de Métrologie*. She was elected to the Board of the European Federation of Medical Physicists where she serves as the European Matters Committee Chair.

4.4.7. Chemistry

R.I. Wielgosz is a BIPM representative to the IUPAC ICTNS, ISO TC 212, Clinical laboratory testing and *in vitro* diagnostic test systems, Working Group 2 on Reference Systems, and ISO TC 146 on Air Quality, and is a member of the editorial board of *Accreditation and Quality Assurance*. He is a member of the WMO-BIPM Joint Liaison Group.

S. Westwood is the BIPM and CCQM liaison to the ISO-REMCO and is a member of the World Anti-Doping Agency (WADA) Laboratory Expert Group.

R. Josephs is the BIPM representative to the Inter-Agency Meeting and the Codex Committee on Methods of Analysis and Sampling (CCMAS) of the Codex Alimentarius Commission.

J. Viallon is the BIPM representative at ISO TC 146/SC 3 on Air Quality – Ambient Atmospheres.

5. ACTIVITIES RELATED TO THE WORK OF CONSULTATIVE COMMITTEES

5.1. Units

C. Thomas is the Executive Secretary of the Consultative Committee for Units (CCU). She is a member of the CCEM Working Group on Proposed Modifications to the SI (WGSI) and the CCEM Working Group for RMO Coordination (CCEM-WGRMO), a member of the CCM Working Group on Changes to the SI kilogram (CCM WGSI-kg), a member of the CCRI RMO Working Group on IR CMCs (RMOWG), and observer of the CCT Working Group on Key Comparisons (WG7).

Over the period covered by this report C. Thomas participated in a large number of Consultative Committee, Working Group, and other meetings held at the BIPM headquarters.

5.2. Mass/Thermometry

A. Picard is Executive Secretary of the Consultative Committee for Mass and Related Quantities (CCM) and the Consultative Committee for Thermometry (CCT) and is a member of several working groups (WGs) and task groups (TGs) of these Consultative Committees (CCs), such as the CCM Working Group on Mass Standards (WGM) TG1 and TG2; the CCM Working Group on Changes to the SI kilogram (WGSI-kg); the CCM Working Group on Strategy (WGS); the CCT Task Group on the SI (CCT TG-SI); the CCT Working Group on Strategy (WGS); and the CCT Working Group on Thermodynamic

temperature determinations and extension of the ITS-90 to lower temperatures (WG 4).

E. de Mirandés has been involved in the CCM Working Group on Mass Standards (WGM) TG2 and the CCM Working Group on Strategy (WGS) in 2012.

5.3. Length/Time and Frequency

E.F. Arias is Executive Secretary of the Consultative Committee for Time and Frequency (CCTF). She is a member of the CCTF Working Group on Two-Way Satellite Time and Frequency Transfer (TWSTFT), the CCTF Working Group on Primary Frequency Standards (WGPFS) and the CCTF Working Group on TAI (WGTAI).

Z. Jiang is a member of the CCTF Working Group on TWSTFT.

W. Lewandowski is Secretary of the CCTF Working Group on TWSTFT and Secretary of the CCTF Working Group on Global Navigation Satellite Systems Time-Transfer Standards (CGGTTS).

G. Panfilo is a member of the CCTF Working Group on Primary Frequency Standards (WGPFS) and of the Sub-Group on Algorithms of the CCTF Working Group on TAI and collaborates with the CCTF Working Group on the CIPM MRA (WGMRA).

G. Petit is a member of the CCTF Working Group on TAI and its Sub-Group on Algorithms, of the WGPFS, and of the CGGTTS.

L. Robertsson is Executive Secretary of the Consultative Committee for Length (CCL) and a member of the CCL Working Group on Strategic Planning (WG-S) and of the Discussion group DG-11 (Lasers). He is the BIPM representative on the CCM Working Group on Gravimetry (WGG).

5.4. Electricity and Magnetism/Photometry and Radiometry

M. Stock is the Executive Secretary of the Consultative Committee for Electricity and Magnetism (CCEM) and the Consultative Committee for Photometry and Radiometry (CCPR) and a member of several of their Working Groups. The 21st CCPR meeting was held on 23 to 24 February 2012. At present the next CCEM meeting is being organized for March 2013 and CCPR working group meetings are planned for April 2013.

R. Goebel organizes the review of comparison reports and protocols within the CCPR Working Group on Key Comparisons (WG-KC).

N. Fletcher acted as the scientific secretary of the BIPM Workshop on Challenges in Metrology for Dynamic Measurement, held at the BIPM headquarters on 15 to 16 November 2012.

5.5. Ionizing Radiation/Acoustics, Ultrasound and Vibration

P.J. Allisy-Roberts was Executive Secretary of the Consultative Committee for Ionizing Radiation (CCRI) until she retired on 31 May 2012, D.T. Burns acted *ad interim* until J.M. Los Arcos took over as the new Executive Secretary from 1 July 2012. There was one CCRI meeting in May 2012 and six Working Group meetings in 2012.

J.M. Los Arcos is the Chairman of the CCRI(II) Working Group on the Extension of the SIR to beta-emitters using liquid scintillation (ESWG(II)), which met in May 2012.

C. Michotte is the coordinator of the CCRI(II) Transfer Instrument Working Group (TIWG(II)), which

met in May 2012, and a member of the Key Comparisons Working Group (KCWG(II)) which met in May and December 2012.

G. Ratel is a member of the CCRI(II) Working Group on the Extension of the SIR to beta-emitters using liquid scintillation (ESWG(II)), which met on 9 May 2012 and for which he was the *rapporteur*, the KCWG(II) which met on 10 May and 3 to 4 December 2012, the Transfer Instrument Working Group (TIWG(II)) which met on 10 May 2012 and the Working Group on Realization of the becquerel (BqWG(II)) which met on 9 May 2012.

D.T. Burns is a member of the CCRI(I) Key Comparisons Working Group (KCWG(I)), Accelerator Dosimetry Working Group (ADWG(I)) and Brachytherapy Standards Working Group (BSWG(I)) and also of an *ad hoc* group evaluating the effect of excess charge on the value for W_{air}. Since 2009 he has been *rapporteur* at annual meetings of the CCRI.

S. Picard is Executive Secretary of the Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV), which held its 8th meeting on 13 to 14 June 2012. The CCAUV Working Group for RMO Coordination (CCAUV-RMOWG), the CCAUV Working Group on Strategic Planning (CCAUV-SPWG) and the newly constituted CCAUV Working Group for Key Comparisons (CCAUV-KCWG) met on 11 to 12 June 2012. She is also the Interim Acting Executive Secretary of the Consultative Committee for Thermometry (CCT) since August 2012.

5.6. Chemistry

R.I. Wielgosz is the Executive Secretary of the Consultative Committee for Amount of Substance: Metrology in Chemistry (CCQM) and a member of the CCQM Strategic Planning Working Group. The CCQM held its 18th meeting at the BIPM headquarters on 19 to 20 April 2012, and was preceded by meetings of its working groups.

S. Westwood is a member of the CCQM Working Group on Organic Analysis (OAWG) and the CCQM Organic Analysis Working Group Taskforce on Core Key Competencies.

R. Josephs is a member of the CCQM Working Group on Bioanalysis (BAWG) and the CCQM Working Group on Organic Analysis (OAWG).

J. Viallon is a member of the CCQM Working Group on Gas Analysis (GAWG).

E. Flores is a member of the CCQM Working Group on Gas Analysis (GAWG).

S. Maniguet is a member of the CCQM Working Group on Organic Analysis (OAWG) and the CCQM Working Group on Key Comparisons and CMC Quality (KCWG).

6. MEETINGS AND WORKSHOPS AT THE BIPM HEADQUARTERS

6.1. Meetings in 2012

6.1.1. The *ad hoc* Working Group on the role, mission, objectives, long-term financial stability, strategic direction and governance of the BIPM

14 to 16 March 2012

During its 24th meeting in October 2011, the General Conference on Weights and Measures (CGPM) decided that the CIPM would establish an *ad hoc* Working Group to review the role, mission, objectives,

long-term financial stability, strategic direction and governance of the BIPM (Resolution 10 (2011)). The *ad hoc* Working Group, chaired by the President of the CIPM, was composed of a number of representatives from Member States and NMI Directors together with the CIPM Secretary and BIPM Director.

In preparation for this meeting, a briefing paper had been prepared by the Chair of the *ad hoc* Working Group and circulated to its members before the meeting. The five topics for discussion were (i) Role, Mission and Objectives for the BIPM in the 21st Century (ii) Scientific Priority Setting (iii) the Role of Regional Metrology Organizations (RMOs) (iv) CIPM and Governance (v) Accountability. The *ad hoc* Working Group produced a summary of its findings and 20 recommendations for consideration by the CIPM which were circulated to all Member States and NMI Directors.

A review of these 20 recommendations made by the *ad hoc* Working Group was conducted by the CIPM at its meeting on 6 to 8 June 2012 and the outcome of this review was presented to a joint meeting of representatives of Member States and NMI Directors on 16 to 17 October 2012. The *ad hoc* Working Group will produce a final report on the Review with findings and recommendations by March 2013, to be presented to the CIPM, Member States and NMI Directors.

6.1.2. Meeting of representatives of Member States and National Metrology Institute (NMI) Directors

16 to 17 October 2012

The main topics of discussion were: the BIPM Programme of Work and Budget for 2013 to 2015; and the report of the *ad hoc* Working Group on the role, mission, objectives, long-term financial stability, strategic direction and governance of the BIPM established by the CIPM in accordance with Resolution 10 (2011) by the CGPM at its 24th meeting.

The BIPM's revised Programme of Work and Budget for the three-year period 2013 to 2015 was presented in detail, along with the expected cost savings when compared to the draft Programme of Work and Budget for the four-year period 2013 to 2016 as submitted to the CGPM. The prioritization was necessary following the adoption of Resolution 3 (2011) by the CGPM which included a three-year dotation. Other decisions and considerations were necessary for the prioritization:

- The dotation, compared to the 2012 dotation to which was added the 2012 contributions of those States that acceded to the Metre Convention since the previous CGPM meeting, will be increased by 1 % per year.
- The additional discretionary contribution agreed for the period 2009 to 2012 will be discontinued.
- Subscriptions of Associate States will be increased in accordance with Resolution 4 (2011).
- The need to replenish the capital investment fund (CIF) was recognized [Resolution 3 (2011)].
- The expenditure during the years 2013 to 2015 should be fully balanced by the income.
- Activities of the Programme of Work 2009 to 2012 should be continued during the Programme of Work 2013 to 2015 to a maximum possible extent.

There was general agreement among the representatives of Member States and NMI Directors that a strategic long-term perspective is needed for the BIPM and that they would like more involvement and greater transparency during the planning and preparation of the Programme of Work. Their increased involvement should not however become an exercise in 'micromanagement'. Involving the representatives of Member States and NMI Directors to a greater extent during the early planning of the Programme of Work should increase the likelihood that the Programme of Work and the corresponding dotation align more effectively with Member States' expectations. This issue is addressed in Recommendation 2 of the *ad hoc* Working Group.

The report of the *ad hoc* Working Group was discussed in great detail and included presentations on: the conclusions and recommendations of the *ad hoc* Working Group; the CIPM position on the recommendations; the procedure to implement Recommendation 2 of the *ad hoc* Working Group; and the formation of CIPM Standing Sub-Committees and *ad hoc* Working Groups to address the major issues raised by the *ad hoc* Working Group. The discussions resulted in a series of conclusions to each of the *ad hoc* Working Group Recommendations. The meeting concluded with three presentations: updating the CIPM MRA and related JCRB matters; the CIPM MRA after 13 years - lessons learned and ways to improve; and metrology for the 2020s.

6.2. Workshops in 2012

6.2.1. BIPM Workshop on Challenges in Metrology for Dynamic Measurement

15 to 16 November 2012

The BIPM Workshop on Challenges in Metrology for Dynamic Measurement was held at the BIPM headquarters on 15 to 16 November 2012, attended by 58 scientists from 21 countries. The subject encompasses many areas of metrology, which were well represented in the diverse gathering. There were nine technical talks from invited speakers from both industry and NMIs, followed by a series of breakout sessions to discuss outcomes for specific areas. It is still true that traceability to the SI from NMI-level to the calibration laboratory is mostly available on a static basis, with just a few facilities in some NMIs where research in the field of dynamic measurement is performed. In particular, verification of dynamic measurement capabilities via key comparisons is a long way off, due to a lack of validated methods and accepted procedures. However, this successful and productive workshop helped to bring out the common problems and solutions, and will act as a reference point for ongoing developments. A report summarizing the breakout discussions and conclusions and recommendations from the workshop is in preparation, and will be published on the BIPM website.

6.2.2. CCM Workshop on the *mise en pratique* of the new definition of the kilogram

21 to 22 November 2012

The CCM hosted a workshop on the *mise en pratique* of the new definition of the kilogram at the BIPM headquarters on 21 to 22 November 2012. Approximately 55 people attended. Technical talks included progress being made toward realizing the proposed new definition of the kilogram using the x-ray crystal density technique (often referred to as the 'Avogadro' method) and electromagnetic techniques (often referred to as the 'watt balance' method). In addition to realizing the new definition through a robust set of operational experiments, workshop discussions also focused on ways of disseminating the kilogram unit to best meet the needs of scientific, legal and industrial mass metrology. The workshop achieved its objective to improve the present draft of the *mise en pratique* that is being produced by the CCM in anticipation of the new definition.

7. BIPM TRAVEL, VISITORS, SECONDEES AND GUEST WORKERS

7.1. Travel

BIPM staff attended over 85 conferences and meetings in 2012. Attendance totalled approximately 346 working days and involved 30 members of the BIPM staff. Twenty one lectures were presented. For

further details about staff travel please see the website
http://www.bipm.org/en/publications/directors_report/travel.html.

In addition, more than 150 working days involving 20 members of the BIPM staff were spent in technical visits to 11 states in 2012.

7.2. Secondees and guest workers

- A.Ö. Altan (UME), on secondment as the JCRB Executive Secretary, 10 December 2010 to 9 December 2012.
- A. Zeggagh (Ecole des Mines, Douai), 16 May 2011 to 28 September 2012, to work on the BIPM watt balance project.
- J. Lan (Tsinghua University and the NIM), 2 January to 27 June 2012, to work on the BIPM watt balance project.
- J. Alvarez (ININ), 20 March to 26 June 2012, to work in the Ionizing Radiation Department.
- K. Tworek (GUM), 1 June to 30 November 2012, to work in the Chemistry Department.
- C. Carmeli (University of Birmingham), 18 June to 18 July 2012, to work in the Ionizing Radiation Department.
- C. Kuanbayev (KazInMetr RSE), on secondment as the JCRB Executive Secretary, 1 October 2012 to 30 November 2014.

7.3. Visitors

More than 120 visitors from 28 states spent a total of 158 days in technical visits at the BIPM in 2012. For further details about these visits please see the website
http://www.bipm.org/en/publications/directors_report/visitors.html.

8. PUBLICATIONS

A fixed term of office for members of the Editorial Board of *Metrologia* was introduced in May 2012 and the terms of reference were clarified, broadly in line with those of other IOPP journals. A number of long-serving members of *Metrologia*'s Editorial Board retired during 2012. The BIPM offers its sincere thanks to the retiring members, Dr Laurie Besley, Prof. Christian Borde, Prof. Patrick Gill, Prof. George Gillies, Prof. Lev Issaev, Prof. Giorgio Moscati and Dr Akira Ooiwa, for the hard work and time they have so kindly dedicated to *Metrologia* over the years. The BIPM extends a warm welcome to the incoming members of the Board, Dr Walter Bich, Dr Richard Davis, Dr Lars Nielsen, Prof. Erkki Ikonen, Prof. Judah Levine, Dr Mike Sargent, Dr Rod White and Dr Jonathan Williams, and also thanks the remaining members, Dr Giovanni Mana, Prof. Fritz Riehle and Dr Barry Taylor, for their continuing contributions.

Special issues of *Metrologia* devoted to subjects of timely interest continue to be organized by invited specialist editors in cooperation with the Editor at the BIPM. Two special issues were published in 2012: issue **49**(2) on the 11th International Conference on New Developments and Applications in Optical Radiometry (NEWRAD 2011) and issue **49**(5) on the Conference on Advanced Metrology for Cancer

Therapy (CAMCT 2011). The input of the Guest Editors in producing these important reference volumes is much appreciated.

The Impact Factor[§] of *Metrologia* remains the highest among related journals, and stands at 1.750 for 2011.

Submissions to the journal remain high, and *Metrologia*'s online Technical Supplement is doing well, with an average of one or two new reports added per week.

The BIPM website continues to be the BIPM's primary means of communication; it contains a wealth of information and attracts interest from a diverse audience.

The main website contains almost 3 800 HTML web pages and over 4 000 PDF files. The SI brochure on the website continues to be downloaded approximately 5 000 times per month. The website provides working areas for over 130 distinct committees and working groups: there are more than 300 users of the BIPM discussion forum.

During 2012 both online and paper surveys were undertaken to obtain user feedback on different parts of the website. This feedback constitutes essential input for the BIPM's future refresh of the website, and the BIPM thanks all participants for their comments.

BIPM e-News is published twice a year in June and December and covers all BIPM activities. It is circulated to stakeholders by email and is also available on the BIPM website. *BIPM e-News* is intended to increase the level of communication between the BIPM and the Member States. It supplements the formal reports required under the Metre Convention and highlights recent issues and achievements and reports on major meetings.

BIPM publications are listed in Appendix 1.

9. FINANCE, ADMINISTRATION AND GENERAL SERVICES DEPARTMENT

The Finance, Administration and General Services Department is responsible for the financial and administrative management of the BIPM as well as a wide range of support services. The Department oversees financial, human resources, legal and other services and relations with the Host State's authorities, with States Parties to the Metre Convention and Associates of the CGPM, and with other States, intergovernmental organizations and international bodies. The Department's work covers financial, legal and administrative affairs and the negotiation and daily management of all contracts and agreements entered into by the BIPM.

During 2012, the Finance, Administration and General Services Department prepared the 2011 BIPM Financial Statements and the 2011 Financial Statements of the BIPM Pension and Provident Fund under the International Public Sector Accounting Standard (IPSAS).

The Department followed up a number of decisions made by the CGPM at its 24th meeting, in particular regarding Member States in financial arrears for more than six years. It successfully negotiated two rescheduling agreements, with the Dominican Republic and the Islamic Republic of Iran on 1 August and 19 October 2012, respectively.

[§] The Impact Factor is defined as being the number of citations in the current year to papers published in the previous two years, divided by the number of papers published in the previous two years.

The Department prepared the budget for the BIPM Programme of Work 2013 to 2015 and developed a number of documents in support of the *ad hoc* Working Group on governance, in particular it finalized a Compendium of the main rules and practices applicable to the BIPM.

The Department initiated the setting up of a cost accounting system at the BIPM and launched an actuarial study for the BIPM Pension and Provident Fund.

The Department also launched a number of calls for tenders for the purchase of equipment and services, and arranged several contracts and agreements.

A key task of the Finance, Administration and General Services Department is to review, on a regular basis, the operational activities of the BIPM and to make ongoing improvements in terms of efficiency and savings. In 2012, a reduction of about 10 % of its general services expenses was achieved compared to 2011.

The Finance, Administration and General Services Department prepared a revision of the BIPM Financial Regulations to take into account the decision of the CGPM related to the subscriptions of Associates of the CGPM. This revision was adopted by the CIPM in October 2012.

The Department prepared a revision of the Regulations, Rules and Instructions applicable to Staff members of the BIPM which was adopted by the CIPM in June 2012.

In 2012 the Department arranged more than 130 customs operations in particular for import and export of standards for calibrations and comparisons, worked on the arrangements for the recruitment of three staff members on a limited-term and permanent basis, and arranged various secondments and internships.

The Finance, Administration and General Services Department supported the International Liaison and Communication Department in the review of BIPM publications.

Finally, three internal Quality audits took place in the Department in 2012 related to: procurement, training and transport and customs operations. All relevant procedures and forms were reviewed and updated where necessary.

9.1. Accounts

Details of the 2011 Financial statements can be found in the "*Rapport annuel aux Gouvernements des Hautes parties contractantes sur la situation administrative et financière du Bureau International des Poids et Mesures*".

9.2. Staff

9.2.1. Appointments

- Miss Nina De Sousa Dias, appointed as *secrétaire* in the International Liaison and Communication Department and in the Secretariat Section since 15 April 2010, had her appointment extended until 14 April 2013.
- Mr José María Los Arcos Merino, born 27 August 1950 in Plentzia (Spain), Spanish nationality, previously Research and Development Advisor at CIEMAT (Spain), was appointed Director of the Ionizing Radiation Department as of 1 July 2012.
- Dr Martin Milton, born 26 June 1961 in Eastbourne (United Kingdom), British nationality, previously a NPL Fellow in Chemical Metrology at the National Physical Laboratory in Teddington (United Kingdom), was appointed *sous-directeur – directeur désigné* of the BIPM as of

1 October 2012 according to the decision of the CIPM during session I of its 101st meeting in June 2012.

9.2.2. Promotions and change of grade

- Mr Andrew Henson, *Responsable des relations internationales*, was promoted Director of the newly created International Liaison and Communication Department from 1 January 2012.
- Dr Hao Fang, *physicien* in the Mass Department, was promoted *physicien principal* from 1 January 2012.
- Dr Stéphane Solve, *physicien* in the Electricity Department, was promoted *physicien principal* from 1 January 2012.
- Miss Pauline Barat, *technicien* in the Mass Department, was promoted *technicien principal* from 1 January 2012.
- Mr Stéphane Segura, *mécanicien* in the Workshop Section, was promoted *mécanicien principal* from 1 January 2012.

9.2.3. Changes of post and transfer

In order to improve the efficiency of the organizational structure of the BIPM, the International Liaison and Communication Department was created from 1 January 2012. Six staff were transferred to the Department: Miss Nina De Sousa Dias, Dr Stéphanie Maniguet, Dr Janet Miles, Miss Céline Planche, Mr Robert Sitton and Dr Claudine Thomas.

BIPM IT Services have been placed under the supervision of the Director of the Chemistry Department from 1 January 2012. IT Services consists of two staff: Mr Laurent Le Mée and Mr Phouc Thierry Nguyen.

The Communication and Information Section was renamed the Secretariat Section from 1 January 2012. There are three staff in the Section: Mrs Céline Fellag Ariouet, Mrs Frédérique de Hargues and Mrs Françoise Joly.

9.2.4. Research fellows

- Dr Norbert Stoppacher, appointed as Research Fellow in the Chemistry Department since 3 January 2011, had his appointment extended until 31 December 2013.

9.2.5. Departures

- Prof. Michael Kühne, *directeur* of the BIPM since 1 January 2011 left the BIPM on 31 December 2012.

Prof. Kühne was thanked for his service at the BIPM on behalf of the CIPM by the Secretary of the CIPM at a reception on 10 December 2012.

- Dr Penelope Allisy-Roberts, Director of the Ionizing Radiation Department, retired on 31 May 2012 after 18 years of service.

- Mrs Françoise Joly, head of to the Secretariat section, retired on 31 December 2012 after 15 years of service.

On their retirement, the Director thanked each of these members of staff for the effective and devoted service during their years at the BIPM.

- Mr Bruno Amaro Coelho, Quality, Health and Safety Manager, left the BIPM on 31 December 2012 at the end of his fixed-term appointment.

9.3. Buildings

The following maintenance and improvement activities were carried out in 2012:

Grand Pavillon: renovation of the roof, refurbishment of one entrance hall, refurbishment of the kitchen and partial refurbishment of the corridor in the basement.

Petit Pavillon: refurbishment of the small meeting room.

Observatoire: installation of a new IT room in rooms 10 and 11A and refurbishment of a corridor at the back of the building.

Ionizing Radiation building: replacement of the air-conditioning equipment in the SIR room.

The Laser building: renovation of the bathroom in the BIPM accommodation.

Pavillon du Mail: replacement of two windows on the 3rd floor; painting of the windows on the 3rd floor, renovation of a number of shutters on the 2nd floor, installation of a storage room for painting materials and installation of a cloakroom in the workshop.

All buildings: upgrade of the IT cable network and replacement of the cells of the electric generator.

Outbuildings and park: partial replacement of the fence.

10. OTHER SUPPORT ACTIVITIES

10.1. Secretariat

The BIPM secretariat provides secretarial support to the Director, Director Designate (when in place) and to members of staff (e.g. support for travel, visa requests, registration for international symposia). The secretariat also organizes the numerous meetings held at the BIPM headquarters and outside the BIPM.

The workload of the Secretariat is linked to these meetings which are mainly those of the Consultative Committees and their Working Groups, but also include meetings of the CIPM, CIPM bureau, Joint Committees and special workshops. See Appendix 3 for a full list of meetings held at the BIPM headquarters in 2012. The Secretariat ensures the smooth running of all these meetings along with the mailing of the associated documents. Some of these meetings involve many delegates and include parallel sessions across the BIPM and occasional sessions off-site.

Among its other responsibilities, the BIPM Secretariat is responsible for the central database which supplies data to the BIPM intranet and website. The database includes a list of participants in all BIPM meetings, representatives of Member States, and embassies in Paris; it enables the section to define the lists of recipients of publications, *BIPM e-News* and to suggest invitees for receptions. The most important documents for communication with Member States, Associates of the CGPM, NMI Directors, Consultative Committees and Working Groups are published by the secretariat on dedicated restricted areas of the BIPM website. It also maintains records of calibration certificates and sends the certificates to NMIs. The secretariat issues the internal monthly "News" of events and it designs the electronic and paper New Year card.

10.2. Library

The library is an essential component of the BIPM's infrastructure in the efficient pursuit of its scientific work and in the provision of translation services for all departments and sections.

In recognition of the need to operate with financial efficiency, and the generic increased use of electronic resources over traditional printed publications, the BIPM undertook a survey of its information needs and its journal subscriptions. As a result a number of subscriptions were terminated, or were converted to electronic-only versions during 2012.

10.3. Information Technology

IT Services implemented an effective project management system in 2012 which has allowed it to more efficiently meet the BIPM's IT needs, both related to maintenance and development of current systems and the implementation of a new IT network and infrastructure at the BIPM.

The goal of the IT infrastructure project is to upgrade the BIPM's IT infrastructure and network so that it will remain reliable and secure and meet users' future needs. Major achievements in 2012 included the construction of a new IT server room, the laying and testing of a new fibre optic network, and specification and review of tenders for the installation of layers 2 and 3 of the IT network. The new network is expected to be fully operational by the end of 2013.

IT Services has continued to run its system maintenance and development projects, including updating of the firewall system, and the site-wide Wi-Fi system used extensively for meetings held at the BIPM. IT services has carried out an audit of the IT hardware and software in the BIPM laboratories. This will allow the scientific departments to plan their replacement and upgrade needs in the future.

IT Services continues to undertake the installation, administration and maintenance of about 30 servers and 200 office- or laboratory-based PCs, and maintain and develop intranet and website applications for the BIPM.

10.4. Quality, Health and Safety

The BIPM Quality Management System was reviewed in the yearly Quality Management System Review meeting on 5 October 2012. A new integrated BIPM Quality Manual, which is in compliance with ISO/IEC 17025:2005 and the ISO Guide 34:2009 has been approved and implemented. The regular internal and external on-site peer reviews which took place during 2012 detected no major non-conformities. Minor non-compliances and recommendations for improvement have been addressed.

The BIPM has continued to work on implementing an Occupational Health and Safety Management System based on the requirements of BS OHSAS 18001:2007. The English version of the BIPM's Occupational Health and Safety Manual was approved and published in September 2012, and the French version is being corrected and will be approved in January 2013. Risk assessment and urgent action procedures have been implemented. An implementation plan has been drafted, and this will enable the Health and Safety Management System to become fully operational in the second half of 2013.

10.5. Mechanical Workshop

The BIPM workshop provides support for all BIPM experimental work, including support for visiting scientists during comparisons and calibrations, in addition to its role in site maintenance and planning services. Of particular note during 2012 has been the continuing effort devoted to the construction and improvement of the BIPM watt balance and the BIPM ensemble of reference mass standards. The workshop's expertise provides essential support for the Mass Department through its unique facilities for the manufacture of kilogram artefacts and vacuum apparatus.

Annexe 1 / Appendix 1

PUBLICATIONS

Publications du BIPM pour l'année 2012 / BIPM Publications 2012

- Procès-verbaux du Comité international des poids et mesures, 100e session (2011), 79, 247 p. / International Committee for Weights and Measures, 100th meeting (2011), 79, 247 pp.
- *Rapport annuel aux Gouvernements des Hautes Parties contractantes sur la situation administrative et financière du Bureau international des poids et mesures en 2011*, 236p. / 236 pp.
- Rapport du directeur sur l'activité et la gestion du Bureau international des poids et mesures (juillet 2010 – décembre 2011), **12**, 172 p. / Director's Report on the Activity and Management of the BIPM (July 2010 – Dec 2011), **12**, 172 pp.
- *BIPM e-News* (juin 2012 et décembre 2012 / June 2012 and December 2012).
- Comité consultatif pour la quantité de matière : métrologie en chimie, 18e session (2012), 37 p. / Consultative Committee for Amount of Substance: Metrology in Chemistry, 18th meeting (2012), 37 pp.
- Comité consultatif des rayonnements ionisants, 22e session (2011), 96 p. / Consultative Committee for Ionizing Radiation, 22nd meeting (2011), 96 pp.
- Comité consultatif de thermométrie, 26e session (2012), 36 p. / Consultative Committee for Thermometry, 26th meeting (2012), 36 pp.
- Comité consultatif du temps et des fréquences, 19e session (2012), 68 p. / Consultative Committee for Time and Frequency, 19th meeting (2012), 68 pp.
- *Notification des parts contributives dues par les Gouvernements des Hautes Parties contractantes pour l'entretien du Bureau international des poids et mesures et des souscriptions des États et Entités Économiques associés à la Conférence générale en 2012*, 4 p. / 4 pp.
- Rapport annuel du BIPM sur les activités du temps (2011), 105 p. / BIPM Annual Report on Time Activities (2011), 105 pp.
- Rapports BIPM:
  - 2012/01 (12 pages), 2012/02 (12 pages), 2012/03 (10 pages), 2012/04 (8 pages).

Publications scientifiques du BIPM pour l'année 2012 / BIPM scientific publications 2012

Masses / Mass

- Baumann H., *et al*, Realization of the anticipated definition of the kilogram. *Proc. 2012 Conference on Precision Electromagnetic Measurements (CPEM)*, 2012, 340-341.

Temps / Time

Publications extérieures / External publications

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- Francis O., Rothleitner Ch., Jiang Z., Accurate determination of the Earth Tidal Parameters at the BIPM to support the watt balance project, *Proc. IAG Symposium*, **139**, 2012.
- Jiang Z., Becker M., Jousset P., Coulomb A., Tisserand L., Boulanger P., Lequin D., Lhermitte F., Houillon J.L., Dupont F., High precision levelling supporting the International Comparison of Absolute Gravimeters, *Metrologia*, 2012, **49**(1), 41-48.
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- Pálinkáš V., Liard J., Jiang Z., On the effective position of the free-fall solution and the self-attraction effect of the FG5 gravimeters, *Metrologia*, 2012, **49**(4), 552-559.
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- Petit G., Panfilo G., Comparison of frequency standards used for TAI, *IEEE T. Instrum. Meas.*, 2012, 99, 1-6.

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- Goebel R., Kim W.-S., Fletcher N., Stock M., Bilateral comparison of 10 kΩ standards (ongoing BIPM key comparison BIPM.EM-K13.b) between the KRISS (Rep. of Korea) and the BIPM, *Metrologia*, 2012, **49**, *Tech. Suppl.*, 01006.
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Balance du watt / Watt balance

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Rayonnements ionisants / Ionizing Radiation

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- Bé M.-M., *et al*, Standardization, decay data measurements and evaluation of ^{64}Cu, *Appl. Radiat. Isot.*, 2012, **70**(9), 1894-1899.
- Bich W., *et al*, Revision of the *'Guide to the Expression of Uncertainty in Measurement'*, *Metrologia*, 2012, 49(6), 702-705.
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Publications du BIPM / BIPM publications

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Annexe 2 / Appendix 2

Certificats et notes d'étude / Certificates and Study Notes

Entre le 1er janvier 2012 et le 31 décembre 2012, 88 certificats et 4 notes d'étude ont été délivrés. / In the period from 1 January 2012 to 31 December 2012, 88 Certificates and 4 Study Notes were issued.

Certificats / Certificates

1.	1 kg mass standard in stainless steel, 3S2*	VSL, Pays-Bas/ Netherlands
2.	1 kg mass standard in stainless steel, 4S2*	Id.
3.	1 kg mass prototype, No. 48*	Danemark/ Denmark
4.	1 kg mass prototype, No. 79*	États-Unis d'Amérique/ United States of America
5.	1 kg mass standard, SMD1+*	SMD-ENS, SPF Economie, Belgique/ Belgium
6.	1 kg mass standard, NSCCL*	CESMEC, Chili/Chile
7.	1 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01200	UME, Turquie/ Turkey
8.	1 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01203*	Id.
9.	10 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01076*	Id.
10.	10 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01077*	Id.
11.	100 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01196*	Id.
12.	100 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01669	Id.
13.	10 000 Ω resistance standard, Leeds and Northrup type 4214, No. 1 857 471*	UTE, Uruguay

* Les étalons marqués d'un astérisque ont déjà été étalonnés au BIPM. / Standards marked with an asterisk have been calibrated previously at the BIPM.

14.	1 Ω resistance standard, Leeds and Northrup type 4210, No. 1 877 783*	Id.
15.	1 kg mass prototype, No. 72*	République de Corée/ Republic of Korea
16.	1 kg mass standard, MP4	CEM, Espagne/ Spain
17.	Ionization chamber PTW 30013, No. 2016 in a ^{60}Co gamma-ray beam*	NIS, Égypte/ Egypt
18.	Ionization chamber NE 2561, No. 229 in a 60Co gamma-ray beam*	Id.
19.	Ionization chamber NE 2530, No. 424 in a 137Cs gamma-ray beam	Id.
20.	Ionization chamber PTW 30013, No. 2016 in medium-energy x-rays*	Id.
21.	Ionization chamber PTW 23342, No. 1250 in low-energy x-rays*	Id.
22.	Ionization chamber PTW 23343, No. 2862 in low-energy x-rays	Id.
23.	1 kg mass standard in stainless steel, No. 74	KIM-LIPI, Indonésie/ Indonesia
24.	1 kg mass standard in stainless steel, No. 112491*	Id.
25.	1 kg mass standard in stainless steel, No. 112492*	Id.
26.	1 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01245*	NMC, A*STAR, Singapour/ Singapore
27.	10 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01244*	Id.
28.	100 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01240*	Id.
29.	Ionization chamber NE 2611, No. 129 in a 60Co gamma-ray beam	METAS, Suisse/ Switzerland
30.	1 kg mass prototype, No. 85*	États-Unis d'Amérique/ United States of America
31.	Ionization chamber Radcal RC6M, No. 10111 in mammography x-rays	ININ, Mexique/ Mexico
32.	Ionization chamber Radcal RC6M, No. 10111 in low-energy x-rays	Id.
33.	Ionization chamber Exradin A3-92717, No. XR072954 in medium-energy x-rays	Id.

34.	Ionization chamber Exradin A4, No. 169 in gamma-ray beams	CMI, République tchèque/ Czech Republic
35.	Ionization chamber Exradin A4, No. 169 in medium-energy x-rays	Id.
36.	Ionization chamber Radcal RC6M, No. 9113 in mammography x-rays	Id.
37.	Ionization chamber Radcal RC6M, No. 9113 in low-energy x-rays	Id.
38.	Ionization chamber ND 1001, No. 7814 in gamma-ray beams*	BIM, Bulgarie/ Bulgaria
39.	Ozone analyzer Advanced Pollution Instrumentation 400, No. 823*	NMISA, Afrique du Sud/South Africa
40.	1 kg mass prototype, No. 57*	Inde/India
41.	1 kg mass standard, P0296	HMI, Croatie/ Croatia
42.	1 kg mass standard, P120684	Id.
43.	1 kg mass standard, P41204998	Id.
44.	1 kg mass standard, P41205001	Id.
45.	Ionization chamber PTW TN31010, No. 2163 in a 60Co gamma-ray beam	KRISS, République de Corée/ Republic of Korea
46.	Ionization chamber PTW TW30001, No. 2229 in a 60Co gamma-ray beam	Id.
47.	Ionization chamber NE 2571, No. NE 2571 in a 60Co gamma-ray beam*	CMI, République tchèque/ Czech Republic
48.	10 000 Ω resistance standard, type Tegam SP5121, No. A2010800	Id.
49.	1 Ω resistance standard, Leeds and Northrup type 4210B, No. 1711458*	INMETRO, Brésil/Brazil
50.	1 Ω resistance standard, Leeds and Northrup type 4210B, No. 1883427*	Id.
51.	10 000 Ω resistance standard, ESI type SR104, No. 043007*	Id.
52.	1 kg mass standard, 013501/00*	EIM, Grèce/ Greece
53.	1 kg mass standard, 013504/00*	Id.

54.	1 kg mass standard, No. 48*	INTI, Argentine/ Argentina
55.	1 kg mass standard, K30*	Id.
56.	1 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01284*	NMISA, Afrique du Sud/South Africa
57.	1 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01285*	Id.
58.	10 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01286*	Id.
59.	100 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01287*	Id.
60.	1 kg mass standard, 3S2*	VSL, Pays-Bas/ Netherlands
61.	1 kg mass standard, 4S2*	Id.
62.	1 Ω resistance standard, type NML, No. S-60657*	NMIA, Australie/ Australia
63.	1 Ω resistance standard, type NML, No. 64177*	Id.
64.	1 Ω resistance standard, type NML, No. 64173*	Id.
65.	Ionization chamber Radcal 10X5-6M, No. 8302 in low-energy x-ray*s	SSM, Suède/ Sweden
66.	Ionization chamber Exradin A3, No. 169 in medium-energy x-rays*	Id.
67.	Ionization chamber NE 2571, No. 2597 in a ^{60}Co gamma-ray beam*	Id.
68.	Ionization chamber NE 2571, No. 2061 in a ^{60}Co gamma-ray beam*	Id.
69.	Ionization chamber Exradin A4, No. 231 in gamma-ray beam*	Id.
70.	10 pF capacitance standard, General Radio model 1408-A, No. 164	MKEH, Hongrie/ Hungary
71.	1 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01358*	NIMT, Thaïlande/ Thailand
72.	10 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01359*	Id.
73.	100 pF capacitance standard, Andeen-Hargerling model AH11A, No. 01360*	Id.
74.	10 pF capacitance standard, Andeen-Hargerling model AH11A, No. 01693	Id.
75.	10 pF capacitance standard, Andeen-Hargerling model AH11A	Id.
76.	10 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01695	Id.

77.	1 Ω resistance standard, ZIP type P321, No. 076165*	BIM, Bulgarie/ Bulgaria
78.	1 Ω resistance standard, MI type 9210A/1, No. 1100574*	Id.
79.	1 Ω resistance standard, MI type 9210A/1, No. 1100576*	Id.
80.	100 Ω resistance standard, Tinsley type 5685A, No. 11769/12*	Id.
81.	10 000 Ω resistance standard, ESI type SR 104, No. J1-0824605*	Id.
82.	10 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01468	NRC-CNRC, Canada
83.	100 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01059*	Id.
84.	10 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01016*	VSL, Pays-Bas/ Netherlands
85.	10 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01017*	Id.
86.	100 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01215*	Id.
87.	100 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01216*	Id.
88.	1 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01015*	CEM, Espagne/ Spain

Notes d'étude / Study Notes

1.	12 906 Ω resistance standard, type Tegam SP5121, No. A2010800	CMI, République tchèque/ Czech Republic
2.	10 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01014	CEM, Espagne/Spain
3.	10 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01219	Id.
4.	100 pF capacitance standard, Andeen-Hagerling model AH11A, No. 01008	Id.

Annexe 3 / Appendix 3

RÉUNIONS ET PRÉSENTATIONS AU SIÈGE DU BIPM / MEETINGS AND PRESENTATIONS AT THE BIPM HEADQUARTERS

Réunions organisées par le BIPM / Meetings organized by the BIPM

Les réunions suivantes se sont tenues au siège du BIPM entre le 1er janvier 2012 et le 31 décembre 2012 / The following meetings were held at the BIPM headquarters between 1 January 2012 and 31 December 2012:

- 21e réunion du CCPR et réunions de ses groupes de travail, du 21 au 24 février 2012 / The 21st meeting of the CCPR and meetings of the CCPR Working Groups – 21 to 24 February 2012.
- Réunion bilatérale BIPM-ILAC, le 7 mars 2012 / BIPM and ILAC bilateral meeting – 7 March 2012.
- Réunion quadripartite BIPM-ILAC-ISO-OIML, le 8 mars 2012 / BIPM, ILAC, ISO and OIML four-partite meeting – 8 March 2012.
- Réunion bilatérale BIPM-OIML, le 8 mars 2012 / BIPM and OIML bilateral meeting – 8 March 2012.
- Réunion du bureau du CIPM, les 9 et 10 mars 2012, 4 et 5 juin 2012, et 14 et 15 octobre 2012 / Bureau of the CIPM meeting – 9 to 10 March 2012, 4 to 5 June 2012 and 14 to 15 October 2012.
- Réunion du Groupe de travail *ad hoc* sur le rôle, la mission, les objectifs, la stabilité financière à long terme, la direction stratégique et la gouvernance du BIPM, du 14 au 16 mars 2012 / *ad hoc* Working Group on the Role, Mission, Objectives, Long-term Financial Stability, Strategic Direction and Governance of the BIPM – 14 to 16 March 2012.
- 28e réunion du JCRB, les 3 et 4 avril 2012 / The 28th meeting of the JCRB – 3 to 4 April 2012.
- 18e réunion du CCQM et réunions de ses groupes de travail, du 13 au 20 avril 2012 / The 18th meeting of the CCQM and meetings of the CCQM Working Groups – 13 to 20 April 2012.
- Réunions des Groupes de travail de la Section II du CCRI sur l'extension du SIR aux émetteurs de rayonnement β au moyen de la méthode par scintillation et sur la réalisation du becquerel, le 9 mai 2012 / The CCRI(II) Working Group on Extension of the SIR to β-emitters using liquid scintillation (ESWG) and the Working Group on Realization of the Becquerel (BqWG) – 9 May 2012.
- Réunion du Groupe de travail de la Section II du CCRI sur l'instrument de transfert, le 10 mai 2012 / The CCRI(II) Transfer Instrument Working Group (TIWG) – 10 May 2012.
- Réunion du Groupe de travail de la Section II du CCRI sur les comparaisons clés, les 10 et 11 mai 2012 / The CCRI(II) Key Comparisons Working Group (KCWG) – 10 to 11 May 2012.
- 23 e réunion du CCRI, les 14 et 15 mai 2012 / The 23rd meeting of the CCRI – 14 to 15 May 2012.
- 26e réunion du CCT et réunions de ses groupes de travail, du 21 au 25 mai 2012 / The 26th meeting of the CCT and meetings of the CCT Working Groups – 21 to 25 May 2012.
- Première partie de la 101e session du CIPM, du 6 au 8 juin 2012 / Session I of the 101st meeting of the CIPM – 6 to 8 June 2012.

- 8e réunion du CCAUV et réunions de ses groupes de travail, du 11 au 15 juin 2012 / The 8th meeting of the CCAUV and meetings of the CCAUV Working Groups – 11 to 15 June 2012.
- Réunion du Groupe de travail 1 du JCGM sur le GUM, du 12 au 15 juin 2012 / JCGM-WG1 (GUM) meeting – 12 to 15 June 2012.
- Réunion du Comité technique de l'AFRIMETS sur l'acoustique, les ultrasons et les vibrations, le 15 juin 2012 / AFRIMETS TC AUV meeting – 15 June 2012.
- Réunion du Groupe de travail 2 du JCGM sur le VIM, du 20 au 22 juin 2012 / JCGM-WG2 (VIM) meeting – 20 to 22 June 2012.
- 19e réunion du CCTF et réunions de ses groupes de travail, du 6 au 14 septembre 2012 / The 19th meeting of the CCTF and meetings of the CCTF Working Groups – 6 to 14 September 2012.
- 15e réunion du CCL et réunions de ses groupes de travail, du 17 au 20 septembre 2012 / The 15th meeting of the CCL and meetings of the CCL Working Groups – 17 to 20 September 2012.
- Réunion des représentants des États Membres et des directeurs des laboratoires nationaux de métrologie, les 16 et 17 octobre 2012 / Meeting of Representatives of Member States and NMI Directors – 16 to 17 October 2012.
- Deuxième partie de la 101e session du CIPM, les 18 et 19 octobre 2012 / Session II of the 101st meeting of the CIPM – 18 to 19 October 2012.
- Atelier du BIPM sur les défis en métrologie pour les mesures dynamiques, les 15 et 16 novembre 2012 / BIPM Workshop on Challenges in Metrology for Dynamic Measurement – 15 to 16 November 2012.
- Atelier du CCM sur la mise en pratique de la nouvelle définition du kilogramme, du 20 au 23 novembre 2012 / CCM Workshop on the *mise en pratique* of the new definition of the kilogram – 20 to 23 November 2012.
- Réunion du Groupe de travail 1 du JCGM sur le GUM, du 27 au 30 novembre 2012 / JCGM-WG1 (GUM) meeting – 27 to 30 November 2012.
- Réunion du Groupe de travail 2 du JCGM sur le VIM, les 3 et 4 décembre 2012 / JCGM-WG2 (VIM) meeting – 3 to 4 December 2012.
- Réunion du Groupe de travail de la Section II du CCRI sur les comparaisons clés, les 3, 4 et 6 décembre 2012 / The CCRI(II) Key Comparisons Working Group (KCWG) – 3 to 4 and 6 December 2012.
- Réunion plénière du JCGM, le 5 décembre 2012 / JCGM plenary meeting – 5 December 2012.
- Réunion du Comité exécutif du JCTLM, les 6 et 7 décembre 2012 / JCTLM Executive Committee – 6 to 7 December 2012

Présentations au siège du BIPM / Presentations at the BIPM headquarters

- T.J. Quinn (Directeur honoraire du BIPM / Emeritus Director of the BIPM), M.E. Himbert (LNE-CNAM), N. Fletcher (BIPM), Hommage à Pierre Giacomo / 'Homage to P. Giacomo' – 9 février 2012 / 9 February 2012.
- N. Dimarcq (LNE/SYRTE), Les investissements d'avenir et le temps-fréquence : le labex FIRST-TF, les equipex REFIMEVE et OSCILLATOR-IMP – 5 avril 2012 / 5 April 2012.
- J. Lan (Tsinghua University), The NIM Joule Balance – 3 mai 2012 / 3 May 2012.
- J. Viallon (BIPM), Ozone absorption cross-sections measurements at the BIPM – 28 juin 2012 / 28 June 2012.
- C. Michotte (BIPM), ^{99m}Tc activity comparison using the transfer instrument of the SIR – 25 octobre 2012 / 25 October 2012.

Annexe 4 / Appendix 4

LISTE DU PERSONNEL DU BUREAU INTERNATIONAL DES POIDS ET MESURES / STAFF OF THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES

au 31 décembre 2012 / on 31 December 2012

Directeur / Director: M. Kühne

Sous-directeur, directeur désigné / Deputy Director/Director Designate: M. Milton

Masses / Mass: A. Picard

P. Barat, H. Fang, C. Goyon-Taillade, F. Idrees[**], A. Kiss, E. de Mirandés

Temps / Time: E.F. Arias

A. Harmegnies, Z. Jiang, H. Konaté, W. Lewandowski, G. Panfilo, G. Petit, L. Robertsson, L. Tisserand

Électricité / Electricity: M. Stock

R. Chayramy, N.E. Fletcher, R. Goebel, A. Jaouen††, B. Rolland, S. Solve[‡‡]

Rayonnements ionisants / Ionizing radiation: J.M. Los Arcos

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

Chimie / Chemistry: R.I. Wielgosz

T. Choteau, A. Daireaux, E. Flores Jardines, R.D. Josephs, P. Moussay, N. Stoppacher, J. Viallon, S.W. Westwood

Finances, Administration et Services généraux / Finance, administration and general services: B. Perent

I. Andernack, S. Arlen, F. Ausset, A. Da Ponte, L. Dell'Oro, C. Dias Nunes, D. Etter, M.-J. Fernandes, M.-J. Martin, A. Mendes de Matos, I. Neves, A. Zongo

Relations internationales et Communication / International Liaison and Communication: A.S. Henson

N. De Sousa Dias[§§], S. Maniguet[***], J.R. Miles, C. Planche, R. Sitton, C. Thomas

Services informatiques / IT Services: R.I. Wielgosz

L. Le Mée, T. Nguyen

Qualité, santé et sécurité / Quality, Health and Safety: B. Coelho

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** Également à la chimie / Also Chemistry
†† Sous le régime de l'invalidité / Under the invalidity scheme
‡‡ En détachement au NIST depuis le 1er juillet 2012 / On secondment to the NIST since 1 July 2012
§§ Également au secrétariat / Also Secretariat
*** Également à la chimie / Also Chemistry

Secrétariat / Secretariat: F. Joly
C. Fellag Ariouet, F. de Hargues

Atelier de mécanique et entretien du site / Workshop and site maintenance: A. Dupire
P. Benoit, F. Boyer, M. de Carvalho†††, E. Dominguez‡‡‡, P. Lemartrier, C. Neves§§§, S. Segura, B. Vincent

Directeurs honoraires / Emeritus directors: T.J. Quinn, A.J. Wallard

Physicien chercheur principal honoraire / Honorary Principal Research Physicist:
R.S. Davis

††† Sous le régime de l'invalidité / Under the invalidity scheme
‡‡‡ Également aux services généraux / Also General Services
§§§ Également aux services généraux / Also General Services

Annexe 5 / Appendix 5

LISTE DES SIGLES UTILISÉS DANS LE PRÉSENT VOLUME / ACRONYMS USED IN THE PRESENT VOLUME

AACC	American Association for Clinical Chemistry (États-Unis d'Amérique/United States of America)
ADWG(I)	CCRI(I) Accelerator Dosimetry Working Group
AFRIMETS	Système intra-africain de métrologie/Intra-Africa Metrology System
AIC	ILAC Accreditation Issues Committee/Comité de l'ILAC sur les questions d'accréditation
AIEA	Agence internationale de l'énergie atomique
AMA	Agence mondiale antidopage
ANEP	Agencia Nacional de Evaluación y Prospectiva/National Evaluation and Foresight Agency (Espagne/Spain)
APMP	Asia Pacific Metrology Programme
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency (Australie/Australia)
BARC	Bhabha Atomic Research Centre (Inde/India)
BAWG	CCQM Working Group on Bioanalysis
BEV	*Bundesamt für Eich- und Vermessungswesen* (Autriche/Austria)
BIM	Bulgarian Institute for Metrology (Bulgarie/Bulgaria)
BIML	Bureau international de métrologie légale/International Bureau of Legal Metrology
BIPM	Bureau international des poids et mesures/International Bureau of Weights and Measures
BOBS	Botswana Bureau of Standards (Botswana)
BqWG(II)	CCRI(II) Working Group on the realization of the becquerel
BS OHSAS	British Standard for Occupational Health and Safety Assessment Series
BSWG(I)	CCRI(I) Brachytherapy Standards Working Group
CAMCT	Conference on Advanced Metrology for Cancer Therapy
CC	Comité consultatif du CIPM/Consultative Committee of the CIPM
CCAUV	Comité consultatif de l'acoustique, des ultrasons et des vibrations/Consultative Committee for Acoustics, Ultrasound and Vibration
CCEM	Comité consultatif d'électricité et magnétisme/Consultative Committee for Electricity and Magnetism
CCL	Comité consultatif des longueurs/Consultative Committee for Length
CCM	Comité consultatif pour la masse et les grandeurs apparentées/Consultative Committee for Mass and Related Quantities
CCMAS	Codex Committee on Methods of Analysis and Sampling
CCPR	Comité consultatif de photométrie et radiométrie/Consultative Committee for Photometry and Radiometry

CCQM	Comité consultatif pour la quantité de matière : métrologie en chimie/Consultative Committee for Amount of Substance: Metrology in Chemistry
CCRI	Comité consultatif des rayonnements ionisants/Consultative Committee for Ionizing Radiation
CCRI(I)	CCRI Section I: x- and gamma rays, charged particles
CCRI(II)	CCRI Section II: Measurement of radionuclides
CCT	Comité consultatif de thermométrie/Consultative Committee for Thermometry
CCTF	Comité consultatif du temps et des fréquences/Consultative Committee for Time and Frequency
CCU	Comité consultatif des unités/Consultative Committee for Units
CEI	Commission électrotechnique internationale
CGGTTS	CCTF Working Group on Global Navigation Satellite Systems Time-Transfer Standards
CGPM	Conférence générale des poids et mesures/General Conference on Weights and Measures
CIE	Commission internationale de l'éclairage/International Commission on Illumination
CIEMAT	*Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas* (Espagne/Spain)
CIF	Capital investment fund
CIPM	Comité international des poids et mesures/ International Committee for Weights and Measures
CIPM MRA	CIPM Mutual Recognition Arrangement/Arrangement de reconnaissance mutuelle du CIPM
CMC	Calibration and Measurement Capability/Aptitude en matière de mesures et d'étalonnages
CMI	Czech Metrological Institute/*Český Metrologický Institut* (République tchèque/Czech Republic)
CNEA	*Comisión Nacional de Energía Atómica* (Argentine/Argentina)
CNES	Centre national d'études spatiales (France)
CNRC	Conseil national de recherches Canada (Canada)
CODATA	Committee on Data for Science and Technology
CONICET	Argentine Council of Research (Argentine/Argentina)
COOMET	Coopération métrologique entre les États d'Europe centrale/Euro-Asian Cooperation of National Metrological Institutions
CPEM	Conference on Precision Electromagnetic Measurements
DPG	*Deutsche Physikalische Gesellschaft*/German Physical Society (Allemagne/Germany)
EAL	Échelle atomique libre/Free Atomic Time Scale
ECVs	Essential Climate Variables
EIT-90	Échelle internationale de température de 1990
EMRP	European Metrology Research Programme/Programme européen de recherche en Métrologie
ENAC	Entidad Nacional de Acreditación/Spanish National Accreditation Body

ENEA	*Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile* (Italie/Italy)
ESA	Agence spatiale européenne/European Space Agency
ESWG(II)	CCRI(II) Working Group on the Extension of the SIR to beta-emitters using liquid scintillation
EURAMET	European Association of National Metrology Institutes
FAQs	Frequently asked questions
FInstP	Fellow of the Institute of Physics
GAWG	CCQM Working Group on Gas Analysis
GGOS	Global Geodetic Observing System
GLONASS	Global Navigation Satellite System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GULFMET	Gulf Association for Metrology
GUM	*Glówny Urzad Miar/*Central Office of Measures (Pologne/Poland)
GUM	Guide pour l'expression de l'incertitude de mesure/Guide to the Expression of Uncertainty in Measurement/
HCHO	Formaldéhyde/Formaldehyde
HPGe	High-Purity Germanium Spectrometer
IAC	International Avogadro Coordination/Collaboration international sur la constante d'Avogadro
IAEA	International Atomic Energy Agency
IAU	International Astronomical Union
ICG	International Committee on GNSS/Comité international sur les systèmes mondiaux de navigation par satellite
ICRM	International Committee for Radionuclide Metrology
ICRU	International Commission on Radiation Units and Measurements
ICTNS	IUPAC Interdivisional Committee on Terminology, Nomenclature and Symbols
IEC	International Electrotechnical Commission
IERS	International Earth Rotation and Reference Systems Service/Service international de la rotation terrestre et des systèmes de référence
IFCC	International Federation of Clinical Chemistry and Laboratory Medicine/Fédération internationale de chimie clinique et médecine de laboratoire
IFIN-HH	"*Horia Halubei*" National Institute of Research and Development for Physics and Nuclear Engineering (Roumanie/Romania)
IGS	International GNSS Service
ILAC	International Laboratory Accreditation Cooperation
IMBIH	Institute of Metrology of Bosnia and Herzegovina (Bosnie-Herzégovine/Bosnia and Herzegovina)
IMEKO	International Measurement Confederation
ININ	*Instituto Nacional de Investigaciones Nucleares* (Mexique/Mexico)
INRIM	*Istituto Nazionale di Ricerca Metrologica* (Italie/Italy)

IoP	Institute of Physics (Royaume-Uni de Grande-Bretagne et d'Irlande du Nord/UK)
IPSAS	International Public Sector Accounting Standard
IRA	Institut universitaire de radiophysique appliquée (Suisse/Switzerland)
IRMM	Institute for Reference Materials and Measurements, European Commission/Institut des matériaux et mesures de référence, Commission européenne
ISO	Organisation internationale de normalisation/International Organization for Standardization
ISO REMCO	ISO Committee on Reference Materials/Comité pour les matériaux de référence de l'ISO
IT	Information Technology
ITS-90	International Temperature Scale of 1990
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
IUPAC	International Union of Pure and Applied Chemistry
IVD	*in vitro* diagnostic
IVS	International VLBI Service
JCGM	Joint Committee for Guides in Metrology/Comité commun pour les guides en métrologie
JCRB	Joint Committee of the Regional Metrology Organizations and the BIPM/Comité mixte des organisations régionales de métrologie et du BIPM
JCTLM	Joint Committee for Traceability in Laboratory Medicine/Comité commun pour la traçabilité en médecine de laboratoire
JLG	Joint Liaison Group
JRP	Joint Research Project
KazInMetr RSE	Kazakh Institute of Metrology RSE (Kazakhstan)
KCDB	BIPM key comparison database/Base de données du BIPM sur les comparaisons clés
KCWG(I)	CCRI(I) Key Comparisons Working Group
KCWG(II)	CCRI(II) Key Comparisons Working Group
KRISS	Korea Research Institute of Standards and Science (République de Corée/Republic of Korea)
LNE-CNAM	LNE, Conservatoire National des Arts et Métiers (France)
LNE-LNHB	LNE, Laboratoire National Henri Becquerel (France)
LNE-SYRTE	LNE, Systèmes de référence temps-espace (France)
LNMRI	*Laboratório Nacional de Metrologia das Radiações Ionizantes* (Brésil/Brazil)
METAS	Institut fédéral de métrologie/Federal Institute of Metrology (Suisse/Switzerland)
MKEH	Hungarian Trade Licensing Office (Hongrie/Hungary)
MoU	Memorandum of Understanding
NCSLI	National Conference of Standards Laboratories International
NEWRAD	Conference on New Developments and Applications in Optical Radiometry
NIM	National Institute of Metrology (Chine/China)
NIS	National Institute for Standards (Égypte/Egypt)

NIST	National Institute of Standards and Technology (États-Unis d'Amérique/United States of America)
NMI	National Metrology Institute
NMIA	National Measurement Institute, Australia (Australie/Australia)
NMIJ	National Metrology Institute of Japan (Japon/Japan)
NMISA	National Metrology Institute of South Africa (Afrique du Sud/South Africa)
NMS	National Measurement System (Royaume-Uni de Grande-Bretagne et d'Irlande du Nord/UK)
NPL	National Physical Laboratory (Royaume-Uni de Grande-Bretagne et d'Irlande du Nord/UK)
NRC	National Research Council of Canada (Canada)
NSCL	National Standards Calibration Laboratory (République arabe syrienne/Syrian Arab Republic)
NSI	Namibian Standards Institution (Namibie/Namibia)
OAWG	CCQM Working Group on Organic Analysis
OIML	Organisation internationale de métrologie légale/International Organization of Legal Metrology
OMM	Organisation météorologique mondiale
OMS	Organisation mondiale de la santé
PJVS	Programmable Josephson voltage standard
POLATOM RC	National Centre for Nuclear Research, Radioisotope Centre (Pologne/Poland)
PPP	Precise Point Positioning/Logiciel de positionnement précis
PTB	*Physikalisch-Technische Bundesanstalt* (Allemagne/Germany)
QMS	Quality Management System
RMO	Regional Metrology Organization
RMOWG	CCRI Regional Metrology Organizations Working Group on Ionizing Radiation CMCs
SI	Système international d'unités/International System of Units
SIM	*Sistema Interamericano de Metrología*/Système interaméricain de métrologie/Inter-American Metrology System
SIR	Système international de référence pour les mesures d'activité d'émetteurs de rayonnement gamma/International Reference System for gamma-ray emitting radionuclides
SIRTI	Instrument de transfert du SIR/Transfer Instrument of the SIR
SmCo	Samarium cobalt
SNS	Superconductor-normal conductor-superconductor/Supraconducteur-normal supraconducteur
SPRT	Standard Platinum Resistance Thermometer/Thermomètre à résistance de platine étalon
SPWG	CCAUV Working Group on Strategic Planning
SSDL	Secondary Standards Dosimetry Laboratories of the IAEA
TAI	Temps atomique international/International Atomic Time
TC-M	EURAMET Technical Committee of Mass and Related Quantities
TC-T	EURAMET Technical Committee of Thermometry

TDCR	Triple-to-Double Coincidence Ratio Technique/Rapport des coïncidences triples aux coïncidences doubles
TG	Task Group
TGFC	CODATA Task Group on Fundamental Constants
TG-SI	CCT Task Group on the SI
TIWG(II)	CCRI(II) Transfer Instrument Working Group
TWSTFT	Two-Way Satellite Time and Frequency Transfer/Comparaison de temps et de fréquence par aller et retour sur satellite
UAI	Union astronomique internationale
UIT	Union internationale des télécommunications
UIT-R	Union internationale des télécommunications , secteur Radiocommunications
UK	United Kingdom of Great Britain and Northern Ireland
UME	*Ulusal Metroloji Enstitüsü*/National Metrology Institute (Turquie/Turkey)
USA	United States of America
UTC	Temps universel coordonné/Coordinated Universal Time
UTCr	UTC rapide/rapid UTC
VIM	Vocabulaire international de métrologie – Concepts fondamentaux et généraux et termes associés (3e édition)/International Vocabulary of Metrology, Basic and General Concepts and Associated Terms (3rd edition)
VIN	International Vocabulary for Nominal Properties/Vocabulaire international pour les propriétés qualitatives
VNIIM	D.I. Mendeleyev Institute for Metrology, Rostekhregulirovaniye of Russia (Fédération de Russie/Russian Federation)
VSL	Van Swinden Laboratorium (formerly NMi-VSL) (Pays-Bas/Netherlands)
WADA	World Anti-Doping Agency
WG	Working Group
WG7	CCT Working Group on Key Comparisons
WGAC	CCM Working Group on the Avogadro Constant
WGG	CCM Working Group on Gravimetry
WG-KC	CCPR Working Group on Key Comparisons
WGM	CCM Working Group on Mass Standards
WGMRA	CCTF Working Group on the CIPM MRA
WGPFS	CCTF Working Group on Primary Frequency Standards
WGRMO	CCEM Working Group for RMO Coordination
WGS	Working Group on Strategy
WG-S	CCL Working Group on Strategic Planning
WGSI	CCEM Working Group on Proposed Modifications to the SI
WGSI-kg	CCM Working Group on Changes to the SI kilogram
WGTAI	CCTF Working Group on TAI
WHO	World Health Organization
WMO	World Meteorological Organization