Bureau International des Poids et Mesures

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

Report of the 23rd meeting
(27-28 April 2017)
to the International Committee for Weights and Measures

Comité international des poids et mesures

LIST OF MEMBERS OF THE CONSULTATIVE COMMITTEE FOR AMOUNT OF SUBSTANCE: METROLOGY IN CHEMISTRY AND BIOLOGY

as of 27 April 2017

President

Dr W.E. May, member of the International Committee for Weights and Measures also

National Institute of Standards and Technology, NIST, Gaithersburg, and University of Maryland, College Park MD

Executive Secretary

Dr R. Wielgosz, International Bureau of Weights and Measures [BIPM], Sèvres.

Members

Centro Nacional de Metrología [CENAM], Querétaro.

D.I. Mendeleyev Institute for Metrology, Rosstandart [VNIIM], St Petersburg.

Danish Fundamental Metrology Ltd [DFM], Lyngby.

Dutch National Metrology Institute [VSL], Delft.

Federal Institute for Materials Research and Testing/Bundesanstalt für Material-forschung und –prüfung [BAM] Berlin.

Federal Office of Metrology [METAS], Bern-Wabern.

Health Sciences Authority [HSA], Singapore.

Instituto Nacional de Metrologia, Qualidade e Tecnologia [INMETRO], Rio de Janeiro.

Istituto Nazionale di Ricerca Metrologica [INRIM], Turin.

Korea Research Institute of Standards and Science [KRISS], Daejeon.

Laboratoire National de Métrologie et d'Essais [LNE], Paris.

Laboratory of the Government Chemist [LGC Ltd], Teddington.

National Institute of Metrology [NIM], Beijing.

National Institute of Metrology [NIMT], Pathumthani

National Institute of Standards and Technology [NIST], Gaithersburg.

National Measurement Institute, Australia [NMIA], Lindfield.

National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology [NMIJ/AIST], Tsukuba.

National Metrology Institute of South Africa [NMISA], Pretoria.

National Metrology Institute of Turkey/Ulusal Metroloji Enstitüsü [UME], Gebze-Kocaeli.

National Physical Laboratory [NPL], Teddington.

National Research Council of Canada [NRC], Ottawa.

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig.

RISE Research Institute of Sweden AB [RISE], Borås

Slovak Institute of Metrology/Slovenský Metrologický Ústav [SMU], Bratislava.

State Laboratory [SL], Co. Kildare.

The Director of the International Bureau of Weights and Measures [BIPM], Sèvres.

Observers

Agency for Science, Technology and Research [A*STAR], Singapore.

Bulgarian Institute of Metrology, General Directorate "National Centre of Metrology" [BIM], Sofia.

Central Office of Measures/Glówny Urzad Miar [GUM], Warsaw.

Centro Español de Metrología [CEM], Madrid.

Government Office of the Capital City Budapest [BFKH], Budapest.

Hong Kong Government Laboratory [GLHK], Kowloon.

Instituto Português da Qualidade [IPQ], Caparica

Kenya Bureau of Standards [KEBS], Nairobi

National Physical Laboratory of India [NPLI], New Delhi.

National Physical Laboratory of Israel [INPL], Jerusalem.

Liaisons

Cooperation on International Traceability in Analytical Chemistry [CITAC], Trappes.

European Commission – Joint Research Centre [JRC-Geel], Geel

International Atomic Energy Agency [IAEA].

International Federation of Clinical Chemistry and Laboratory Medicine [IFCC].

International Organization for Standardization, Committee on Reference Materials [ISO REMCO].

International Union of Pure and Applied Chemistry [IUPAC].

1. OPENING OF THE MEETING

The Consultative Committee for Amount of Substance: Metrology in Chemistry and Biology (CCQM) held its twenty third meeting at the International Bureau of Weights of Measures (BIPM), at Sèvres on 27-28 April 2017.

The following were present: M. Akgöz (UME), H. Andres (METAS), A. Botha (NMISA), O. Bottauscio (INRIM), P. Brewer (NPL), R.J.C. Brown (NPL), G. Carroll (SL), S. Choquette (NIST), L. Deleebeeck (DFM), S. Ellison (LGC Ltd), P. Fisicaro (LNE), T. Fujimoto (NMIJ/AIST), C. Gonzalez (NIST), N. Gonzalez-Rojano (CENAM), A.C. Gören (UME), B. Güttler (PTB), J.S. Kim (KRISS), S.K. Kim (KRISS), Y. Kustikov (VNIIM), T.K. Lee (HSA), H. Li (NIM), L. Ma (NIM), L. Mackay (NMIA), M. Máriássy (SMU), S. Marbumrung (NIMT), W.E. May (President of the CCQM), J. Melanson (NRC), Z. Mester (NRC and IUPAC), U. Panne (BAM), S.R. Park (KRISS), H. Parkes (LGC Ltd), E. Pires do Rego (INMETRO), M. Sargent (LGC Ltd), M. Sega (INRIM), A. Takatsu (NMIJ/AIST), N. Tangpaisarnkul (NIMT), T.L. Teo (HSA), J. Ullrich (PTB and CIPM), W. Unger (BAM), A. van der Veen (VSL), S. Vaslin-Reimann (LNE).

Observers: H.A. Chua (A*STAR), F. Dias (IPQ), J. Dumanska (GUM), W. Kozlowski (GUM), I. Mugenya (KEBS), Z.N. Nagyné Szilágyi (BFKH).

Liaisons: H. Emons (JRC-Geel and ISO REMCO), A. Fajgelj (IAEA), L. Samuel (CITAC).

Representatives from Member State invited to attend as Observer: L. Chavarro Medina (INM Colombia), R. Pérez Zambra (LATU).

Invited: M. Buzoianu (INM), V. Dobrovolskiy (VNIIFTRI), P.A. Gatti (INTI), R. Kaarls (CIPM honorary member), H. Klich (INRAP), J. Morrow (NIST), R. Parris (NIST), S. Lin-Gibson.(NIST).

Also present: R. Josephs (BIPM), M.J.T Milton (Director of the BIPM), P. Moussay (BIPM), S. Picard (BIPM / KCDB Coordinator), J. Viallon (BIPM), S. Westwood (BIPM), R. Wielgosz (BIPM / Executive Secretary of the CCQM), N. Zviagin (JCRB Executive Secretary).

Sent regrets: E. Anklam (JRC-Geel), M. Bilsel (UME), D. Moturi (KEBS), M. Tarlov (NIST), T. Fernández Vicente (CEM).

Dr May, President of the CCQM, officially opened the meeting at 9:00 am on 27 April 2017. He thanked the CCQM members for their work over the last year and remarked that attendance during the week of CCQM meetings continued to grow, this year exceeding 250 participants for the first time. Dr May reminded members that 2018 will be the 25th anniversary of the CCQM and he is considering holding a third day of the plenary meeting that will be open to all CCQM attendees. He noted that this larger group would likely require an alternate venue for the meeting, and that the Centre International d'Études Pédagogiques (CIEP) located only a short walk from BIPM might be suitable.

The introduction to the meeting concluded with Dr May initiating a round table self-introduction by all participants and observers.

2. APPOINTMENT OF A RAPPORTEUR

Dr May proposed Dr Jeremy Melanson (NRC) as the rapporteur for the meeting; Dr Melanson agreed, and based on a request from the President also agreed to serve in this capacity in 2018.

3. APPROVAL OF THE AGENDA

The agenda was approved. Dr May noted that for agenda item 12, regional metrology organizations (RMOs) are encouraged moving forward to submit written reports at least four weeks prior to the annual meeting. In addition, Dr May highlighted the importance of agenda item 14, where a more formalised procedure for approval of CCQM key comparison studies will be discussed. Dr Botha proposed also including RMO studies into this discussion on the study approval procedure.

4. REPORT OF THE 22ND MEETING OF THE CCQM

Dr May thanked Dr Richard Brown, rapporteur for the 22nd meeting of the CCQM, for producing the report. The CCQM approved the report. Progress with decisions and actions arising from the 22nd meeting of the CCQM would be taken as part of Dr May's opening presentation.

5. OPENING REMARKS FROM THE CCQM PRESIDENT

Dr May provided an overview of the status of the CCQM. He highlighted two relevant meetings subsequent to the 23rd meeting of the CCQM, namely the 105th CIPM meeting on 26-28 October 2016, and the MRA Implementation and Operations WG meeting on 13-14 March 2017. Dr May noted that as per discussion within the CIPM Bureau, generic objectives for CIPM consultative committees are:

- Improvement in domain-specific measurement science and standards;
- Implementation of the CIPM MRA;
- Provision of metrology-related solutions to address important global/societal issues and stakeholder engagement

Dr May commended the CCQM on its exemplary efforts on the implementation of the CIPM MRA, demonstrating consistency of measurement results through key comparison studies. He also praised

the CCQM for its delivery of metrology-related solutions to address important global issues, through the various services provided by NMIs such as calibration services and certified reference materials. However, Dr May stated that whilst the CCQM activities had undoubtedly improved measurement science and standards, the CCQM may not have emphasized this aspect of its role sufficiently in the past. He therefore reminded members to not lose sight of the research and scientific aspects of the CCQM and encouraged working chairs to hold workshops and seminars in conjunction with their meetings. To promote the enhancement of measurement science, Dr May proposed that the CCQM consider the establishment of metrology prizes to be awarded every 4 years, with nominations from each region and WG chairs to serve as judges. Prize winners would then be given the opportunity to highlight their measurement science achievements with a presentation at an event such as the proposed third day of the CCQM plenary session.

Dr May continued by reviewing the current organizational structure of the CCQM, noting that the CCQM operates in a different manner than most other CCs as its scope is much broader. He highlighted the ten permanent working groups (WGs) and the two current *ad hoc* groups, along with their respective chairs. He noted that the meetings in 2017 had been attended by over 250 delegates with about 70 at the plenary meeting and that this was testing the resources of the BIPM. Dr May then reviewed the dissemination of measurement services in chemistry and biology, currently certified reference materials (CRMs) and calibration services. He noted that 51 % of CMCs underpin CRM services, 25 % of CMCs underpin calibration services, and 24 % underpin combinations of both. Dr May went on to observe that CCQM activities supported over 6 224 calibration and measurement capabilities (CMCs) of the NMIs as of 14 October 2016 that are published in the BIPM key comparison database (KCDB). The number of CMCs is increasing at a rate of about 250 per year. Dr May noted that the CCQM has performed on average about 20 comparisons a year. Whilst these were impressive statistics showing the enormous output of the CC, it was Dr May's opinion that the current rate of growth may not be sustainable for the long term. Dr May then took the opportunity to remind participants of the CCQM's Terms of Reference and responsibilities, namely: The CCQM is responsible for developing, improving and documenting the equivalence of national reference systems for chemical and biological measurements. It advises the CIPM on matters related to chemical and biological measurements including advice on the BIPM's scientific programme.

Dr May reviewed the implementation of core competency approaches for key comparisons. He noted that strategic planning frameworks had been developed, where a finite number of comparisons test the institutional knowledge and core competencies required to deliver metrologically sound measurement services to customers that are recognized under CIPM MRA. Dr May used the OAWG's four-track strategic approach for comparison studies as an example of such a framework. He noted that other WGs use similar approaches, but encouraged the KCWG to continue to work to implement a unified nomenclature for the core comparison approaches being undertaken by different WGs to avoid confusion when communicating outside the CCQM.

Dr May then opened a discussion on the issue of "one result per institute per key comparison", in response to an issue raised by Dr Sargent in last year's CCQM meeting, where results from multiple methods from the same institute are being reported for key comparisons within the IAWG. Since that meeting, other CCQM members have also requested that CCQM should request an exception to the CIPM MRA rule of "one result per institute". Dr May confirmed the current status of this discussion is to not request this exception from the CIPM. As presented in the CIPM meeting of October 2016, Dr May reminded attendees that if a key comparison participant uses multiple methods to measure analytes in a given key comparison, it may be useful for the NMI/DI to record all of its results in its report, which ensures that these results are included in the key comparison report. The participant

may, if it wishes, use a combination of results for its key comparison result for that analyte. However, a participant is not allowed to include more than one result for its KC reported value as used in the study table of results, final degree of equivalence table, or other plots. Therefore, one key comparison result is allowed per institute and the participant must clearly identify this.

Dr May continued with a discussion on overlapping CMCs between and NMIs and designated institutes (DI), based on a request for CCQM to recognize a DI from Australia with specialized measurement capabilities in neutron activation analysis (NAA). Dr May reminded attendees that CIPM-MRA-D-06 states the requirement that the DI not have overlapping scope with the NMI, and the issue is whether CCQM should request an exception for this special case. Dr Mackay stressed the importance of the NAA technique and that the number of NMIs with this capability has been diminishing. She noted the value of NAA for SI-traceability in CRM certification, and the complimentary nature of NAA to isotope dilution – mass spectrometry (ID-MS). Dr May stated that he was not comfortable with the special case just for Australia. He noted that NPL and LGC are required to not have duplicate CMCs and must divide up domain space, as are PTB and BAM. Dr May suggested that a committee be formed consisting of himself, Dr Milton, Dr Wielgosz, and Dr Mackay to discuss this further and propose a solution to be discussed and agreed by the SPWG. Dr Fajgelj commended the effort of CCQM to demonstrate the significance of NAA, but recommended that CCQM should avoid calling this situation a special case as all alternative methods will be then considered special cases going forward. Dr Milton noted that he was optimistic that a path forward could be found without asking CIPM for an exception, but that a case needed to be made on how this specialized NAA facility could add to the MRA.

6. REPORT FROM THE CCQM *AD HOC* WORKING GROUP ON THE MOLE

Dr Güttler reported on progress of the CCQM *ad hoc* working group on the mole after its 6th meeting earlier in the week, reiterating that its tasks were: preparation of a CCQM draft for a *mise-en-pratique* of the mole; providing a response to activities and request from the CCU; providing a response to IUPAC activities and recommendations; and disseminating information for the external community. He continued by highlighting the planning of upcoming dates of importance to the revision of the SI system, and the mole in particular:

- 20 May 2018 – World Metrology Day: This was planned to be the main launch date of the awareness campaign. The focus will be on the SI redefinition with web pages, a poster, social media, and other messages from the BIPM;
- November 2018 – 26th meeting of the CGPM - General Conference on Weights and Measures: It is expected that a resolution to redefine the SI be tabled at this meeting. As part of this conference, the BIPM will be organizing a number of activities, including a press conference to mark the occasion and will look to broadcast the event live. All NMIs are to be kept informed of the plans as they develop;
- 20 May 2019 – World Metrology Day: If approved at the CGPM, this is the anticipated date for the redefined SI to come into practice.

Dr Güttler went on to describe the objectives and activities of the campaign to promote the redefinition of the SI. He highlighted a documentary film currently in production that was funded by

NIST. Dr Güttler also described a brochure produced by PTB published in September 2016 entitled "Experiments to the new SI". This publication is targeted for high school teachers and students, and while currently only available in German from the PTB website, translation to English is in progress. PTB has also produced an information sheet on the new SI, which is available in English on the PTB website (http://www.ptb.de/cms/en/research-development/research-on-the-new-si/info-sheet.html). The CCQM was honoured to have Dr Ullrich in attendance (CIPM Member and CCU President), and he provided an update on the awareness campaign from a CCU perspective. Dr Ullrich explained the work of the public relations group tasked with promoting the SI, which was established at the request of CIPM following the January 2017 meeting. He went on to describe that a logo and brand book had been created, which will be translated into numerous languages. These will be available on a website and sent to all NMIs and CCs. The website will also include a list of frequently asked questions on the new SI and a presentation that NMIs can use when delivering seminars on this topic. Dr Ullrich also confirmed that an SI application for smart phones was in development.

Dr Güttler then reviewed the technical aspects of the proposed redefinition, including the development of a common statement from all CCs to their stakeholders addressing the forthcoming redefinition of the SI. The statement developed for the CCQM and submitted on 10 March 2017, to CCU was: "The revised definition of the mole is based on a specified number of entities (typically atoms or molecules) and does not depend on the definition of the unit of mass, the kilogram. Traceability to the mole can still be established via mass measurements, tables of atomic weights and the molar mass constant M_u. Atomic weights are unaffected by this change in definition and M_u is still 1 g/mol, although now with an uncertainty. This uncertainty is so small that the revised definition of the mole does not require any change to common practice." Dr Güttler then went on to describe the efforts of IUPAC in the redefinition of the mole and highlighted an article in press with *Pure and Applied Chemistry* that was dedicated to IUPAC's provisional recommendation. He proceeded to discuss the definition adapted by the *ad* hoc WG for CCQM and presented the following: "The amount of substance, symbol *n*, of a system is a measure of the number of specified elementary entities. An elementary entity may be an atom, a molecule, an ion, an electron, any other particle or specified group of particles. The mole, symbol mol, is the SI unit of amount of substance. One mole contains exactly 6.022 140 8Y × 10^{23} elementary entities. This number is called the Avogadro number and is the fixed numerical value of the Avogadro constant when expressed in the unit mol^{-1}."

A discussion on the wording of the proposed CCQM definition followed focused mostly on the presence of the words "of a system". Dr Brown remarked that "of a system" needs to be included to define that all entities are grouped together. Dr Wielgosz agreed and added that since this text was part of the original definition, it minimizes changes and increases the chances of gaining approval. Dr May endorsed the use of the two-part statement, with one consistent with the other CCs and the other more specific to the chemistry community. Dr Mester noted that other changes in wording should not be made at this stage. Dr Ullrich expressed his thanks to IUPAC for making the recommendation. Dr Brown noted that inconsistency in wording with other definitions may reduce the chances of being accepted by CCU. Dr May ended the discussion by stating that in the absence of any clear arguments to the contrary, the CCQM would submit the proposed wording above for the definition of the mole for consideration by the CCU, which differed in format to other definitions currently under discussion, but took into account the wording preference expressed by IUPAC.

7. OUTCOMES OF THE CIPM MRA REVIEW OF THE KCDB

7.1. Report from the CCQM *ad hoc* WG on BIPM KCDB 2.0

Dr Wielgosz provided an update on the CCQM *ad hoc* working group on KCDB 2.0 WG, on behalf of its Chair, Dr Sin who sent her regrets. The group was formed following the April 2016 CCQM meeting to provide input into the development of KCDB 2.0. A WebEx meeting and a face-to-face meeting were convened on 23 September and 5 October , respectively, and the WG came up with the following recommendations for consideration of the SPWG:

- The CMC template can be simplified by suppressing the nine columns that describe CRMs. This information can just as well be included in the 'disseminated capability' columns (with ranges and uncertainties adjusted accordingly if necessary).
- The current measurement service categories for the 'Amount of Substance' need to be reviewed, taking into account what these categories are being used for. This may also mean that the CMC template allows listing of a disseminated capability for a number of service categories.
- The WG noted that a common request from the Bio group had been that their description of the measurand may need to be quite lengthy, and a future template/data entry field should not limit this.
- The WG agreed on the proposal to keep the field "Analyte Group" in the current template for now, as it might find use for linking the CMC claim to a HFTLS statement
- The WG supported the proposal to produce a CCQM best practice guide on preferred units to use for expressing CMCs in the KCDB, noting that the choice of units would still be driven by customer requirements, but in other cases it would be possible to harmonize (e.g. to decide whether to use g/g or kg/kg for expressing mass fractions as an example).
- The WG supported the approach being currently investigated by the BIPM on the feasibility of a web-based tool for the complete CMC submission and review giving full tracking of the CMC review process.

A discussion followed that focused primarily on the first recommendation, which proposed a simplification of the CMC template with the removal of nine columns from the CMC template that specifically described CRMs, with the argument that the capabilities for value assigning CRMs could be described also in the columns related to 'Dissemination range of measurement capability'. Dr May reminded members that since not all NMIs produce CRMs, any decision would need to reflect the needs of all NMIs. Dr Máriássy noted that since 75 % of measurement capabilities are related to CRMs, if we remove these columns it will be difficult for customers to find CRMs. Dr May countered that it was previously decided that the KCDB should not resemble a CRM catalogue. Dr Kustikov noted that for Russia the CRM information was very important. Dr Milton suggested that the CCQM template has 37 columns, many more that other CCs, so we should consider if they are all absolutely necessary. Dr Botha suggested that the number of CMCs being reviewed is the primary burden on the CMC reviewers, as opposed to the number of columns in the template. Dr May reminded attendees that NMI services in chemistry can also be proficiency test (PT) sample value assignment, as opposed to just CRMs. Dr Mackay emphasized the need to maintain CRM information in the database and that sufficient effort has been made to familiarize accreditation

bodies with the database as it currently stands. Dr Brewer countered that NPL would prefer to emphasize the capability. Dr Mester pointed out that ISO 17025 covers capabilities and ISO 17034 covers CRMs so he strongly recommended leaving the CRM related columns. Dr Van der Veen commented that VSL did indeed use both the 'Disseminated Capability' and 'CRM' columns, and the CRM columns were maintained to be consistent with the CRMs services they provided. He therefore confirmed that VSL had no wish for the columns on CRMs to be removed from the template. Dr May then put forward the question of whether NMIs would need to resubmit CMCs once the new KCDB system is online. Dr Milton confirmed that it was planned that the BIPM would be able to transfer currently published CMCs into the KCDB 2.0, but some verification steps would need to be foreseen. Dr Wielgosz closed the discussion by stating that since no consensus on this issue could be achieved, the change to the CMC template will not be made at this time and that further discussion will be required.

7.2. Plans for BIPM KCDB 2.0

Dr Picard presented an update on the revision of KCDB 2.0. She began by highlighting the main objectives of the project: better search capabilities, user friendly web support, web based CMC submission and review, and the ability to track comparisons in real time. She then discussed a timeline for the project, with the launch of KCDB 2.0 planned to coincide with the CGPM conference in November 2018. Dr Picard continued by describing the proposed CMC web platform, highlighted by the elimination of the CMC template spreadsheet and the various emails required for its distribution. She then introduced the "Writer – Reviewer – Finder" concept, which will allow for a risk-based evaluation and to proceed via sequential access for both the intra-RMO and inter-RMO reviews, using restricted access user accounts. Dr Picard then reviewed the user interface for tracking the progress of key comparisons in real-time, noting that the system will not be applied for pilot studies, but alerts that pilot studies are taking place can be requested. She then highlighted the improved search functionalities such as an improved thesaurus and the possibility of searching values for measurands and uncertainties within specified ranges. Other improvements to the CMC review procedure were then described, such as the elimination of CMC "batches" and the possibility of a CMC fast-track process for the CCQM. Dr Picard concluded her presentation by raising a series of issues of particular relevance to the CCQM, and she urged the CCQM to harmonize the design of broad-scope CMC claims prior to the implementation of KCDB 2.0.

Dr Botha opened the discussion by inquiring that as pilot study results are not part of the KCDB nor KCDB 2.0, will they still be considered for use in supporting CMCs. Dr May provided assurance that there will be a solution in place for this. Dr May then referred to the previous discussion after the Report from the CCQM *ad hoc* WG on BIPM KCDB 2.0, noting this earlier discussion was likely the result of confusion over nomenclature in the spreadsheet. He recommended that going forward, any discussion on changes of either the internal CMC template or the public-facing KCDB should be considered separately. Dr Milton commented that there were no specific software limitations associated with KCDB 2.0, and that the primary JCRB recommendation was to reduce personnel resources required for review. Dr May then suggested that the CCQM should provide a recommendation to the JCRB on what we needs to be displayed in the KCDB 2.0 and will seek input from RMOs on what information they need to review CMCs.

8. CONSULTATIVE COMMITTEE GOVERNANCE

8.1 Member and Observer Status in CCs

Dr May began his presentation by reviewing decision CIPM/105-27, that stated that for all Consultative Committee meetings in 2017 and thereafter, international organizations will be referred to as "liaisons" and will not be offered membership, and that named individuals will be "guests" or "experts" and will not be offered membership. Dr May confirmed that this decision affected the seating plan of the current meeting, and that while institute designations have changed, affected attendees should not consider this a change in personal status. Dr May then pointed out that he believed the CCQM should be more active in informing new members of the role of CCQM, the value of CMCs, etc., and that the development of measurement services and not just capabilities should be the outcome of the process. As a result he had proposed that a statement of the CIPM MRA goals should be distributed to all new members, with wording similar to the following statement: "Merely developing and articulating capabilities and not delivering measurement/metrology services that are underpinned by such capabilities is not consistent with the spirit of the MRA."

Dr Ellison opened the discussion by asking for clarification on the change of international organizations' status from member to liaison, and inquired which provision had changed. Dr Milton confirmed that this was a new revision introduced by decision of the CIPM. Dr Fajgelj commented that communication on the change of status for international organizations has been poor, and that no information is available on the BIPM website. He further noted that since being invited as a full member in 2002, IAEA has performed numerous comparisons and established 23 CMCs, but it is not clear whether IAEA will be allowed to participate in these activities moving forward. Dr Milton conceded that communication on this issue could have been better, and pledged that documentation would be developed in due course, and document CIPM-MRA-D-01 which dealt with these matters was currently under revision. He noted that the early effect on the CCQM is due only to seating restrictions with the large group and hinted that the changes might not be as drastic as one might think. Dr Brown noted that it is important to know who is eligible to vote. Dr May provided assurance that a list of voting members would be established, but that consensus decisions would be encouraged and every attempt will be made to avoid hard votes. Dr Emons reiterated that there has been little communication on the liaison status decision, and that it will be difficult to decide on participation moving forward. Dr Fajgelj then commented that decisions were taken before consequences were known. He further clarified that he had no complaint with the seating arrangement or liaison status, but suggested this change should be better defined and communicated. Dr May stated that the decision was made by CIPM based on international practices for similar organizations and that the CCQM was only implementing it within its constraints. Dr Ullrich provided assurance that it was the CIPM's wish that all appropriate voices would continue to be heard.

8.2 Process for appointing CC Vice-Presidents

Dr May reported that the CIPM had requested him to re-form the CIPM *ad hoc* Working Group on Membership and to develop a proposal for appointing Vice-Presidents to the Consultative Committees. He noted that the person should be a technical subject matter expert external to the CIPM, and ideally someone currently active on a respective CC. Dr May highlighted the benefits of this new role, such that it will ensure that each CC President has support and assistance from technical subject matter expert. He also noted that this could be used as a tool for CIPM succession planning and could help address concerns about gender equity in leadership with Metre Convention activities that have been raised by the CEC. Dr May concluded by stating that this was only a proposal at this point and that after discussions at the CC President's Meeting in June 2017, a final decision would be made at the CIPM Meeting in October 2017. If approved, the terms of reference for the Vice President positions would be established and that appointments would take place in March 2019, following seating of the new CIPM and appointment of CC Presidents.

8.3 CCQM process for reviewing applications for Members and Observers

Dr Wielgosz presented highlights from the draft document (CCQM/17-07) entitled "CCQM Process for Reviewing Applications from Institutes for CCQM Member/Observer Status". The document had been drafted with the CCQM President, in order to have a more detailed documented process for CCQM Members' applications. He began by reviewing the general criteria for membership as defined by CIPM D-01:

"Membership of a Consultative Committee is open to institutions of Member States of the BIPM that are recognized internationally as most expert in the field. This normally requires that they:

1. be national laboratories charged with establishing national standards in the field;
2. be active in research and have a record of recent publications in research journals of international repute;
3. have demonstrated competence by a record of participation in international comparisons organized either by the Consultative Committee, the BIPM or a regional metrology organization.

Observer status on a CC may be granted to those institutes:

- of Member States and to intergovernmental organizations and international bodies, and scientific unions that actively participate in the activities organized under the auspices of the CC and its working groups but do not yet fulfil all the criteria for membership;
- of an Associate of the CGPM that is not eligible to become a State Party to the Metre Convention when these institutes actively participate in the activities organized under the auspices of the CC and its working groups."

Dr Wielgosz then went on to describe decision CIPM/105-26 following the 105th meeting of the CIPM: "The CIPM decided to revise the Rules for Membership of the Consultative Committees as follows; all Member States will have the right for one national laboratory charged with establishing national standards in the field to be an observer at the applicable Consultative Committee, and to send one person (only) and following their request for each meeting. Such a request should be sent to the BIPM Director. In this case the observer status is not permanent, and a new request must be sent for each meeting."

Dr Wielgosz reviewed the proposed CCQM process for application review and recommendations. Briefly, the applicant would be required to submit a report to the CCQM Executive Secretary describing how the institute meets requirements 1-3 above, along with a review report from an on-site review within the last three years. A small team of relevant experts within CCQM would then be appointed by the CCQM President to review each applicant. If a suitable review report addressing the criteria was not submitted, it was proposed that an onsite assessment of the applicant's institute would be conducted by the assessment team members. The CCQM President and SPWG will review the documentation, findings, and recommendations of the Assessment Team and conduct further discussions with the institute if needed for clarification, with the CCQM President deciding on the recommendation to be made to the CCQM: Membership, Observership, or denial at this time.

Dr May opened the discussion by noting that the document does not specify who finances the potential on-site assessment, and that it should be made clear that it is the applicant organization who funds the visit. He also remarked that a broad interpretation of "research" in requirement 2 should be used. Dr Wielgosz noted that since applicant reports were to be reviewed by international committees, this would require documents to be provided in English to the review committee. Dr Milton remarked that the proposed CCQM peer review visit, was not a requirement for other CCs, and if it was to be applied it should be applied to all Members and not just new members of the CCQM. Dr Wielgosz added that CCQM has not reviewed publications for all current members. Dr May then stated that CCQM put more emphasis on participating in WGs and contributing to studies. He also proposed that moving forward, members should not be assessed solely on study results but more emphasis should be placed on peer review visits. Dr Milton reiterated that on-site visits are not a CIPM criterion for CC membership, and are not a requirement in any other CCs. Dr Sargent added that instead of on-site visits, a representative from the applicant institute could be invited to a CCQM meeting to present their case. Dr Milton agreed and confirmed that this is how all other CCs operate. Dr Morrow pointed out that for emerging areas such as cell analysis, there is significant value of reviewing capabilities in person. Dr May then asked her if review decisions could be made in these areas without on-site visits. Dr Morrow responded that you do not get the same perspective, so it would be much harder to make the decision without the visit. Dr Kaarls suggested that members must be able to contribute to high-level discussion within CCQM, so if an applicant has never been visited or heard from, it will be very difficult to assess. Dr Botha remarked that the way CCQM is currently operating is effective, where representatives become active in WGs before NMIs become members. She also noted that peer review is expensive, and supported Dr Sargent's suggestion for applicants to be invited to CCQM for a presentation. Dr Mackay agreed and added that NMIA participated in WGs for 5 years so members were aware of their track record, so it would have been expensive and disappointing if a peer review visit would have been required. Dr Kaarls agreed in the case of NMIA, but noted that CCQM may have been too flexible in some instances, and some members have not contributed significantly, so there should be some provision to help avoid this. Dr Ellison remarked that the CCQM should not create more rules than the CIPM, and that criteria have already been established and the CCQM should not go beyond that. Dr Lee then shared Singapore's (HSA) experience that began in 2008, where they applied for observer status following the second

peer review, which was very important and helped them extensively. Dr Tangpaisarnkul offered further support for the on-site review, and noted that Thailand (NIMT) also had a peer review before being granted observer status, and successfully submitted their first CMC in 2009. Dr May then asked Dr Lee and Dr Tangpaisarnkul if the peer review visits had been beneficial to them, and they both confirmed that it had been. Dr May then brought the discussion to a conclusion and asked Dr Wielgosz to summarize the discussions so far. Dr Wielgosz summarized that there was no consensus on the requirement for a peer review as part of the CCQM membership application process. He suggested that the rest of the process could be followed, starting with the CCQM President appointing a review team to review the applications received for CCQM Member/Observer Status. The review team would proceed by a paper-based review of the documentation submitted to support the application, and report back to the President with a recommendation, including whether further information is required in order to produce a recommendation. Dr May agreed and appointed a review team of M. Mariassy (Chair), A. Botha, R. Parris and R. Wielgosz to carry out the review of the current membership application.

8.4 CCQM Working Group contact persons

Dr Wielgosz gave a presentation on the BIPM activities aimed at renewing the working group contact lists, as current lists are outdated or redundant. Due to turnover of staff and reorganization within NMIs, it has been determined that simply adding the last person that attended a particular WG meeting to contact lists is not the most appropriate approach. Therefore, NMI Directors have been contacted and asked to provide up to two names per working group they participate in to serve as the contact persons, which are listed on the BIPM website in the public section for each WG. Ms Parkes noted that it should be clearly defined that the contact person(s) should be the person making the decision on who would attend, as opposed to the actual attendee. Dr May and Dr Wielgosz agreed.

8.5 Open access CCQM and CCQM WG documents

Dr Wielgosz led a discussion on potentially increasing the amount of open access information from the CCQM and CCQM working groups on the BIPM website. This issue has surfaced based on feedback from CCQM stakeholders, who expressed concerns that the current levels of information available are not sufficient to adequately describe the scope of current CCQM activities, as well as future directions of the CCQM. Dr Milton noted that other CCs tend to provide much more open access information. Dr May provided assurance that CCQM will make every attempt to provide open access documents, but that information on matters such as ongoing studies will remain protected. Dr May then concluded the discussion by pledging that CCQM will develop guidelines for increasing the number of open access documents, while still protecting sensitive information.

9. OUTCOME OF THE CCQM STRATEGIC PLANNING WORKSHOP AND FINALIZATION OF THE CCQM STRATEGIC PLANNING DOCUMENT (2017-2016)

On the Wednesday afternoon preceding the plenary meeting, a CCQM strategic planning workshop was held, which was open to all confirmed plenary attendees. The workshop consisted of "elevator pitches" (4 minutes) from the eight technical WG chairs, to highlight major achievements since the last period, major challenges, changes in the updated WG strategy, and the number of comparisons per year for the next period. Similar pitches were also sought from the five RMO chairs. A discussion of the draft CCQM 2017-2026 strategic plan document followed, led by Dr Wielgosz. It was decided that the draft be modified to better reflect the three objectives of CCs (progress the state of the art; reach out to new and established stakeholders; demonstrate the global comparability of measurements). Dr Wielgosz was tasked with contacting WG Chairs to provide examples of meeting these objectives and the challenges for the future. It was also decided to better describe the challenges and future requirements in the draft for more coordinated actions between RMOs on comparison organization. It was determined the draft should be reordered, and Working group chairs were also tasked with ensuring their long-term study plans were updated.

10. REPORTS FROM THE CCQM WORKING GROUPS

10.1 CCQM WG on Key Comparisons and CMC Quality (KCWG)

Dr Botha provided an update on the KCWG activities and she noted she was presenting on behalf of Dr Sin who sent her regrets. Dr Botha began by highlighting the growth rate of the chemical and biological CMCs, noting that CCQM activities support 6227 CMCs as of 27 February 2017. She then reviewed the membership of the KCWG and thanked all members for their efforts over the last year. Dr Botha then stated that the meeting of the KCWG had taken place prior to the CCQM on 22-23 April, and she noted that this annual face-to-face meeting is one of the key components of the inter-regional review of chemistry CMCs. In 2017 a total of 1302 CMCs were submitted, of which 398 CMCs were new claims. Dr Botha noted that during Cycle XVIII there had been an improvement in the efficiency of the review process. She also mentioned that while specific claims continue to dominate, a number of broad claim CMCs were submitted, as well as CMCs for method-dependent measurands. Dr Botha then expressed the opinion that when moving towards wider scope CMC claims, more expert review input for the review process may be required. She then stated that a new approach is being taken in the review of CMC claims:

- Use of core comparisons, competence concepts and benchmarking comparisons.
- Fewer comparisons but with more time spent in the planning, design and organization, especially for core and benchmarking comparisons.
- The use of record or report cards, and competence tables developed by some CCQM WGs

- These changes are going to affect how CMCs are reviewed; there may be hardly any one-to-one links between CMCs and KCs in some paradigms
- KCDB 2.0

Dr Botha went on to discuss that going forward the KCWG would continue to enhance effectiveness and efficiency for better adherence to hard deadlines. Vigorous examination of both intra- and inter-regional review processes would continue, as will the re-review of existing CMCs to enhance consistency. She also noted that a task force would be established to identify key factors affecting the efficiency and make recommendations for improving the review process. Dr Botha ended her presentation by discussing several key issue for the KCWG moving forward, noting that the relationships between CMCs and services need further examination for broad claim CMCs. She also cited the need to optimize the frequency at which key comparisons are repeated and also the desire to reduce the number of CMCs on similar services or have them grouped together in order to reduce the burden of CMC review. Dr Botha then reiterated that a revised procedure for bio-CMCs is needed due to limited expertise within the KCWG.

Dr May opened the discussion by making a general comment on the increasing use of acronyms within CCQM and suggested that going forward, CCQM presenters and attendees should define CCQM-specific acronyms they are using throughout presentations and discussions for the benefit of guests and stakeholders. He then commented that broad CMC claims were developed for streamlining the reviewing process, but fears they might become meaningless to our customers. Dr May also suggested to consider changing the wording of “capability” to “assessed capability” in the key comparison database. Dr Emons followed by stating that the current description of CMCs in the database is not very useful for customers with exact concentrations and uncertainties, but will be equally ineffective if listed simply as “any analyte in any matrix”. He also noted that most users of the database are from within the CCQM. Dr May countered that this might be the case at present, but we need to look to the future to plan who will be using the database and how they will interact with it.

Ms Parkes continued the discussion by reaffirming the need to revise the bio-CMC review process, noting there was no meeting planned for the fall as key personnel will be missing. She went on to state that the nucleic acid working group (NAWG) would review CMCs within the group and then they will be submitted to the RMOs in the usual fashion. Ms Parkes noted that this process will only be necessary during this transitional period until more biological experts are identified and appointed to the KCWG. She then suggested that bio-CMCs should be submitted to the relevant working group chair by 15 September 2017. Dr Park confirmed that the protein analysis working group (PAWG) will perform a similar internal review of CMCs. Dr Sargent countered that while the number of bio-CMCs from the inorganic analysis working group (IAWG) is small, an internal CMC review would be difficult to fit in a normal 2-day working group meeting. Dr May suggested that coordination on this issue between the relevant working groups would be required, and noted that it would be discussed further at the Friday evening working group chairs dinner meeting. Dr Morrow then offered to coordinate and document a joint plan for the working groups to review biological CMCs internally.

Dr Wielgosz, based on feedback from JCTLM stakeholders, asked whether there had been any discussion within the KCWG on language requirements for documentation related to CRMs listed within the KCDB, noting that certain CRMs were the basis for traceability for measurement results in many countries and not simply the country of origin of the reference material. Dr Ellison commented that he believed that this was a business decision to be taken by each NMI on what to make available to customers. Dr May reaffirmed that he did not consider this a CCQM decision.

10.2 CCQM WG on Protein Analysis (PAWG)

Dr Park presented a report on the PAWG activities of the last year. He began by highlighting the progress of several studies. He noted that CCQM-K115 and the associated CCQM-P55.2 study on the purity of human C-peptide had been completed successfully and that CMC claims are being prepared. Dr Park confirmed that CCQM-P137 on the activity of alpha-amylase was also completed and the Draft B report was being finalized, and he noted that subsequent key comparison is planned. He then described that preparations were complete for CCQM-P164 on human growth hormone (hGH) in serum, and that the study would begin in May 2017. A study on the quantification of insulin was then described, which will compare conventional protein methods such as amino acid analysis following hydrolysis versus an elemental sulphur method by ICP-MS. This study is planned to begin in November 2017. Dr Park noted that the studies are divided between the activities two focus groups established within PAWG, one working on primary protein calibrators (Focus Group 1) and solutions and the second looking at protein measurements in biological matrices (Focus Group 2). He went on to describe that Focus Group 1 deals with core components for metrological foundation for protein measurements and primary reference materials and calibrators and Focus Group 2 is dedicated to complex matrix measurements. Dr Park then highlighted the study plans for each focus group, noting that CCQM-K115 and the proposed insulin study were in alignment with Focus Group 1's plan, while CCQM-P164 on hGH in serum fit with Focus Group 2's study plan. Dr Park finished by summarizing the Mini-Workshop on Metrology for Protein Biologics held earlier in the week during the PAWG meeting, that consisted of seminars from six NMI representatives and one guest from the biopharmaceutical industry.

Dr May opened the discussion by reminding attendees that WG activities should fall into three main categories, namely improving measurement science, improving comparability, or societal impacts and stakeholder engagement, and asked Dr Park to comment on which categories the protein studies typically fall under. Dr Park responded that for the CCQM-K115 study it would be mostly improving measurement science, but also comparability. Dr May agreed, but noted that while these studies might not address societal issues, these studies move the state-of-the-art in protein measurement science. Dr Wielgosz commented that since the CCQM-P137 study on the activity of alpha-amylase was carried over from the original bio-analysis working group (BAWG), would PAWG be continuing in this area. Dr Park responded that there were six participants for this study and some NMIs deliver services in this area, so there is considerable interest within PAWG. Dr Kustikov then asked since CCQM-P137 was a pilot study, would PAWG be following up with a key comparison. Dr Park confirmed that one value needed to be finalized and after that a key comparison would proceed. Dr May commented that since there will be no gravimetric value, a consensus reference value will need to be established.

Dr May ended the discussion by bringing to the attention of attendees that PAWG had met earlier in the week at the Centre international d'études pédagogiques (CIEP), which is situated a short walk from the BIPM, and asked Dr Park to comment on hosting the PAWG meeting at CIEP. Dr Park confirmed that it was a very appropriate venue. Dr May noted that the CIEP also has auditorium facilities and might be useful for hosting the proposed opening day of the plenary for the 25th anniversary of the CCQM. Dr Milton reminded attendees that CIEP is equipped with many meeting rooms and even lodging used for visiting scientists that may have limited budgets.

10.3 CCQM WG on Nucleic Acid Analysis (NAWG)

Ms Parkes provided an update on NAWG activities and noted increased participation at the working group meeting earlier in the week. She remarked that the working group meeting was attended by 15 nucleic acid experts representing 24 NMIs/DIs, and also noted new participation from INM, BVL, CMI, and NIST. Ms Parkes confirmed that all participants are active in delivering or developing NA measurement services, over a broad range of service provisions. She then reviewed NAWG's terms of reference, and noted that the measurement space for NAWG consisted of the chromosome, epigenome, genome, transcriptome, and regulome. She then discussed the strategy for prioritizing studies based on a NAWG member survey, and highlighted the consideration of stakeholder requirements and a broad range of CMCs to support measurement services. She noted an increased confidence in the scope and clarity of NA measurement space within the NAWG, which has created a sense of "maturity" within the group.

Ms Parkes went on to review completed and ongoing studies, including CCQM-K86c/P123.4, on measuring copy number ratio of modifications in two rapeseed materials, where the high oil content presents a significant technical challenge for the extraction. The *Brassica napus* L. materials included a genetically modified DG-073496-4 rapeseed powder from JRC, and a GT73/RT73 modified material from NRC Canada. In this study, two different FatA fragments were suggested for the two samples as the samples were assessed only with these amplicons, in accordance with respective EU and Canadian service provisions. Preliminary study results were presented and showed reasonable agreement across participating NMIs, but results for the GT73/RT73 material were compromised by some participants who used an incorrect ratio for normalization with the FatA assay. Ms Parkes then reviewed the planned CCQM-P184 study to begin in 2017, designed to support SI-traceable measurement of copy number concentration and fractional abundance of a biologically-relevant mutation (SNV or INDEL) in a buffered solution.

Dr Emons opened the discussion by commenting on the different EU and Canadian service provisions relevant to CCQM-K86c/P123.4, and suggested that there was no barrier to trade as laboratories are not forced to use the same reference system for GMO measurements at the global scale. He also noted that the calculation error that led to the bias for some participants for the GT73/RT73 material is avoided when following properly the regulations.

Dr Lin-Gibson of NIST was then given the opportunity to introduce herself and comment on her involvement in the ISO/TC276 committee on biotechnology and her role as chair of WG3: Analytical Methods. She noted that the scope of ISO/TC276 included improving quality of bioassays and suggested there is a great opportunity to develop synergy as much of the work of the CCQM underpins measurement for stakeholders in industry. Dr Lin-Gibson noted that ISO cannot share documents but could invite a liaison from CCQM to participate on the technical committee. Dr Wielgosz commented that since the CCQM is not officially an organization it cannot function as a liaison, but as in many other WGs, the NMIs working in CCQM have members in relevant ISO technical committees that are nominated by their national standardization body.

10.4 CCQM WG on Cell Analysis (CAWG)

Dr Morrow presented a report on the activities of CAWG and began by reviewing their role. She stated that CAWG was focused on the identification and quantification of cells and cell properties indicative of function as a result of emergent behaviour in complex matrices and mixtures. It was also dedicated to global comparability of cell analytical measurement results through reference measurement systems of the highest possible metrological order with traceability to the SI, where appropriate and feasible. Dr Morrow went on to define "emergent behaviour" as novel properties of cells that arise from a collection of constituents that do not themselves exhibit such properties. She followed that cell analysis includes measurements of quantity of intact cells and cell properties indicative of function that are the result of emergent behaviour, and noted that relevant studies will include quantification of cell number or cell components and measures of biological response or function in the context of cell emergent behaviour. Dr Morrow then described the challenges in counting cells due to biological complexity of cells that can differ in size, shape, function, and role in a broader system. She also added that complications arise during cell cultivation, manipulation, and preservations, and noted a larger diversity in measurement methods and a dynamic instrumentation market.

Dr Morrow then described the activities of three focus groups within CAWG. The first group is dedicated to eukaryotic cell number and coordinated by Dr Campbell of LGC. A second focus group is dedicated to prokaryotic viable cell number and coordinated by Dr Fu of NIM. A third group is also being formed to study blood cell quantities in blood matrix (complete blood count), and establishing traceability to the SI, to be coordinated by PTB.

Dr Morrow continued by reviewing work on past studies, highlighting results from CCQM-P123 on the number and geometric property of cells adhered to a solid substrate and CCQM-P165 on the quantification of CD34+ cell counts. She discussed whether these studies underpin existing services or CMCs, and noted that the CAWG would modify and develop study proposals that build on this knowledge and advance measurement science. She then reviewed an extensive list of current and near-term measurement services provided by each NMI. Dr Morrow closed by reviewing new pilot study proposals anticipated for September 2017. For mammalian cell type, CCQM-P123 will be extended to a different substrate, and building on CCQM-P165, a study will be performed on population dependent cell count by flow cytometry. Dr Morrow also noted that a study would be planned for microbial cell type, building on a previous plate count study but will now employ a method with traceability.

In reference to Dr Morrow mentioning a potential industrial participant for a proposed pilot study, Dr May commented that while non-metre convention members can participate in pilot studies, they must add scientific value and sign a non-disclosure agreement. He also suggested that they must agree to attend the meeting to discuss results and commercial entities can never use their participation in promotional material. Dr Wielgosz then asked Dr Morrow to describe the Trucount™ standard employed for flow cytometry. Dr Morrow responded that it is a commercial internal standard based on number of beads.

10.5 CCQM WG on Surface Analysis (SAWG)

Dr Unger provided an update on the activities of SAWG and opened with a review of the scope of SAWG, which is largely dedicated to measurements for advanced manufacturing. He then reviewed

the core competencies of SAWG, including the composition of films (mol/mol; CCQM-K67, K129), amount of substance expressed as a layer thickness (nm; CCQM-K32), specific surface area (m^2/g) using the Brunauer, Emmett and Teller (BET) method, and 2D and 3D spatially resolved chemical composition where a new pilot study has been proposed. Dr Unger then reviewed outcomes from a joint workshop of IAWG and SAWG on techniques for measurement of nanoparticle number concentration in colloidal suspension. It was concluded that the number of chemically well-defined particles per volume would describe the measurand and that the metrology was sufficiently developed for small-angle X-ray scattering (SAXS) and UV-visible spectroscopy. Another conclusion was that particle number concentration in liquid falls within the scope of CCQM and it is cross-disciplinary so multiple WGs should be involved. Dr Unger also noted that methods could be studies in a parallel CCQM/VAMAS study with careful separation of the activities.

Dr Unger continued by reviewing previous SAWG comparisons, beginning with CCQM-K129 on $CuInGaSe_2$ (CIGS) alloy film composition. The results showed good comparability for the four elements of the film and NIM has since established a CMC in this area, with PTB and KRISS will be following up with a CMC submission. Dr Unger then reviewed the BET method and described its application to CCQM-K136 on the measurement of specific surface area, specific pore volume and pore diameter of a nanoporous alumogel (Al_2O_3). He noted that the measurands of the key comparison are method-defined parameters and the values are determined on the basis of the BET model described in ISO 9277 and ISO 15901-2. Reasonable comparability was demonstrated and CMC claims have been made by UNIIM and NIM. Dr Unger then described a proposed follow-up key comparison on BET, using microporous white quartz sand (SiO_2) as a sample. He continued by proposing a repetition of CCQM-K32 on the thickness measurement of nano-scaled HfO_2 (gate oxide) films on Si wafer, whereas the original study measured a SiO_2 film. He also proposed a new pilot study on the amount of substance in buried organic layers that will evaluate new measurement capabilities for quantitative in-depth nanoscale chemistry by SIMS and XPS using argon cluster sputtering. The measurand in this case would be a layer of Bis[2-(2-pyridinyl-N)phenyl-C](2,4-pentanedionato-O2,O4)iridium(III) (Ir(ppy)2(acac)), sandwiched between two layers of Irganox 1010. Dr Unger concluded his presentation by describing a recently established task group within SAWG working towards traceable quantitative measurements with Raman microscopy.

Dr May opened the discussion by making a general comment that all WG chairs are to submit lists of all proposed studies after the close of the meeting that day. He then inquired about the NIST-traceable nanoparticle, and Dr Unger confirmed that it is simply a NIST SRM. He also noted that the BET studies have method-defined measurands, and put the question to the floor of whether the CCQM should be performing these studies. Dr Ellison commented that enzyme catalysis also has a method-defined measurand. Dr Emons argued that BET is a special case given its widespread use, and noted there are plenty of cases where the measurand is operationally defined. Dr May then suggested that the CCQM should develop a position paper describing the criteria used to decide which method-defined measurands and measurement services were in the scope of activities covered by the CCQM. He then sought volunteers to develop this paper and the following agreed to contribute to the work of the task group to be chaired by Dr Andres: Dr Brown, Dr Ellison, Dr Emons, Dr Güttler, Dr Li, Dr Mester, and Dr Morrow and Dr Wielgosz.

Dr Wielgosz continued the discussion by inquiring about the joint study proposed with VAMAS and asked about the specific contribution of the NMIs and testing laboratories for this study. Dr Unger responded that the study results will need to be separated very carefully and that the non-NMI laboratories are performing pre-standardization research. Dr Mester then commented that when

studies are carried out with set protocols, one goal is to improve methodology, so we should be feeding back this knowledge to the appropriate bodies to improve the methodology.

10.6 CCQM WG on Electrochemical Analysis (EAWG)

Dr Máriássy presented a report on the EAWG and noted that their WG meeting earlier in the week attracted 30 participants from 20 institutes, with 2 new institutes represented for the first time. He then provided an overview of completed studies since 1999, subdivided into three main categories: pH, electrolytic conductivity, and coulometric assays. He also displayed the number of coordinated comparisons by NMIs as of 2016, and noted that PTB, SMU, NIST, and DFM coordinated the majority of studies with the EAWG.

Dr Máriássy went on to review ongoing studies and began with CCQM-K36.2016 on the determination of electrolytic conductivity in aqueous solutions coordinated by PTB. Results for the 0.5 S/m KCl solution showed good agreement, with perhaps one exception, and the median has been proposed as the reference value. Similar results were achieved for the 0.005 S/m HCl solution. Dr Máriássy then showed a comparison of the 0.5 S/m results to those from the original CCQM-K36.a study completed in 2005, and noted that better degrees of equivalence were achieved in the present study. He then showed results for the CCQM-K18.2016 study coordinated by NIST on the determination of pH of a carbonate buffer at a nominal value of 10. The study attracted 19 participants, 16 of which used a primary method and three used a differential method. The spread in the results was small and only a handful of participants' results failed to cover the range of the proposed KCRV.

Dr Máriássy then reviewed highlights of the EAWG guidance document, noting that comparison data was not relevant after 10 years, and suggested different studies every three years. He continued by discussing the issue of broad claims in the context of the EAWG. Dr Máriássy noted that the field is narrow, and the analyte dimension is missing for pH and conductivity. He then reviewed some of the technical challenges with broad claims for pH, conductivity, and coulometry and suggested some practical solutions such as record cards for easier review of the claims. Dr Máriássy concluded by presenting a summary and highlighted good participation in meetings, continuing support for services and CMCs through comparisons and studies, and an increase of knowledge within the EAWG. He also noted major challenges such as decreasing staff and resources, limited number of coordinators for comparisons, and issues with sample delivery.

Dr May opened the discussion by proposing that the name of the EAWG be changed to the Working Group on Electrochemical Analysis and Classical Chemical Methods to better describe the area covered by the WG. There were no objections from Dr Máriássy or other attendees. Dr Brown commented that the scope of the work will need to be updated to reflect the change in name. Dr May agreed and noted that a new terms of reference is also being developed by Dr Máriássy. In reference to the topic of frequency of repeating studies in Dr Máriássy's presentation, Dr May commented that the CIPM MRA was based on the premise that individual institutes maintain capabilities, but noted that there was a dependence on staff turnover in study results. Dr May then remarked that studies may need to be repeated when a number of staff have changed, as opposed to simply repeating studies on a fixed time cycle.

10.7 CCQM WG on Organic Analysis (OAWG)

Dr Mackay provided an update on the OAWG and she began by reviewing the analysis space currently covered within the Track A core competency organic purity comparisons and presented results from CCQM-K55.d on folic acid. She reported that results were all within about 1 % except for a couple of outliers and she noted that stability assessment had also been an important part of this comparison. Dr Mackay then described a revised high purity organics measurement space, where the high molecular weight quadrants for low- and high-polarity were combined, citing that the effects of the much larger molecules outweighs any effects of polarity in terms of the complexity of the measurements. She then introduced CCQM-P150.b, a new Track D stand-alone pilot study examining qNMR organized by NMIJ, which would aim to evaluate the importance of sample preparation, selection of a solvent and internal standard, measurement parameters, and data processing parameters.

Dr Mackay then presented highlights from an organic purity measurement uncertainty workshop, held during the the third quarter 2016 working group meeting at the BIPM, which consisted of presentations by BIPM, HSA, KRISS, NMIJ, and NIST. She noted the importance of consistent practices for uncertainty evaluation within the OAWG, and described the consensus re-evaluation of uncertainties for CCQM-K55.d performed by Dr M. Nelson of NIST. Most laboratories' uncertainties were in reasonable agreement with the consensus uncertainties, with the method of handling of "type B" uncertainty components causing the most discrepancy. Dr Mackay also noted that having a second method for purity is highly valuable and that consensus estimates are particularly robust when both qNMR and mass balance approaches are consistent.

Preliminary results from CCQM-K78.a and CCQM-P121.a on the mass fraction of amino acids in solution were then presented and Dr Mackay remarked that this was one of the most consistent set of study results obtained thus far within the OAWG, especially in the case of phenylalanine. She then presented preliminary results from CCQM-K141/P178 (polar analytes in food matrix: enrofloxacin and sulfadiazine in bovine tissue), and thanked NRC for their efforts in coordinating this study given the challenges with shipping bovine tissue internationally. Moderate agreement was achieved for both measurands, and follow-up work was proposed for the examination of extraction conditions, equilibration of internal standards and calibration solution stability. Dr Mackay then described results for CCQM-K138 on measuring aflatoxins in dried fig, and noted that these were very challenging measurands given the low mass fractions of (0.08 – 9.0) µg/kg. Again, reasonable agreement across the NMIs was achieved for the five aflatoxins and their total.

Dr Mackay then described the OAWG's model to assess core competencies through a 10-year plan and reviewed the OAWG priorities in terms of service areas. She concluded her presentation by summarizing proposed future studies. For Track A core competency studies, these included CCQM-K146/P185 on PAHs in olive oil, CCQM-K148.a/P187.a on bisphenol-A mass fraction, and a clinical biomarker study on metanephrine in plasma proposed for 2019. Within Track B on comparison of services, CCQM-K147/P186 on niacin in milk power/infant formula was proposed for Jun-Dec 2017. Finally, proposed Track C studies in specialized areas included perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) in ground water and CCQM-K133/P170 on phthalates in polyvinyl chloride (PVC).

Dr May opened the discussion by commenting that there were two general types of key comparisons, those that all NMIs participate in and those that are more optional, so we need to be very careful about those studies that we impose on NMIs. He went on to remark that while all studies need to be

approved by this committee, the level of scrutiny for optional ones can be lower, but Track A mandatory comparisons need to be approved as soon as possible in advance to allow NMIs sufficient time to plan resources. Dr Mackay responded that a 12-month lead time for approval of optional studies and 24 months for mandatory studies might be appropriate, and Dr May and others agreed. Dr May then asked for more detail on the rationale for CCQM-K147/P185 on PAHs in olive oil and Dr Mackay responded that the original study was completed roughly 15 years ago so it needs to be repeated. Dr May then noted that since the study is planned for November 2017 it needs to be approved now, and he opened the floor to any concerns for this comparison to go forward. No concerns were raised so Dr May conditionally approved the study, but asked Dr Mackay to provide an updated title and "how far the light shines statement" (HFTLS). The Track A CCQM-K148.a/P187.a (bisphenol A) and clinical biomarkers comparison (metanephrine in plasma) were also approved. Ms. Parkes commented that 2019 might seem far off for the clinical biomarkers study, but LGC needs sufficient time to prepare the material. Similarly, the Track B CCQM-K147/P186 on niacin in milk power/infant formula, in addition to the Track C CCQM-K133/P170 on phthalates in PVC and PFOS/PFOA in ground water, were also approved.

10.8 CCQM WG on Inorganic Analysis (IAWG)

Dr Sargent gave a presentation on the progress of activities within the IAWG, and he began by reviewing the meetings that occurred over the year, including the WG meeting at KRISS in October, and a joint meeting with EAWG and SAWG earlier in the week at BIPM. He then provided a graphical overview of all key comparisons and pilot studies in progress, and noted that all studies are optional to NMIs but a compulsory benchmarking comparison is held every two years. Dr Sargent then presented results of CCQM-K128/P163: Heavy Metals and Organo-Tin in Leather Powder. With a few exceptions, good agreement was achieved for the heavy metals and the tributyltin. Similarly, reasonable equivalency was demonstrated for CCQM-K139/P173: Determination of Elements in Human Serum. Dr Sargent described new comparisons proposed in the area of metallo-proteins, resulting from a joint IAWG-PAWG workshop earlier in the week. These included a proposed NIST study on selenoproteins, a KRISS study on sulfur-based quantitation of insulin, and a PTB pilot study on the determination of total haemoglobin in serum. Dr Sargent highlighted the IAWG's updated five year plan, spanning a wide range of matrix types and analytes, in addition to special pilot studies. He described the IAWG's annual survey and CRM database, currently on its sixth round, noting that it supports IAWG strategy and planning future comparisons, identifies possible gaps in supporting NMI/DI plans for CMCs, identifies candidate CRMs that may be potential sample materials for future comparisons. Dr Sargent concluded his presentation by noting that good progress with comparisons continues, active development of IAWG strategic goals continues, pilot studies play an important role and will continue, and that the majority of member NMIs and DIs are actively participating in IAWG activities, including comparisons.

Dr May opened the discussion by commenting that while the proposed studies are interesting, they might not be strategic as some of them begin to encroach on the scope of other WGs, noting that a protein is an organic molecule. Dr Sargent responded that the studies are designed to test core capabilities, and noted that NIST is developing standards in this area, so it is relevant and proves capability for other proteins. Dr Güttler commented that PTB performs protein determination in different ways, and since the methods are challenging they need to have multiple measurements to

validate results. Dr Wielgosz commented that he appreciated the format of the summary comparison table that Dr Sargent presented ("Five year plan updated in April 2017"), and suggested that other WGs use a similar format to focus on the next 3 years and only highlight changes so discussions are not repeated every year.

Dr Milton continued the discussion by commenting that the CCQM has the largest number of comparisons, and while OAWG has different tracks to show differentiation and strategy, it is difficult to explain to the JCRB how the record card approach has improved efficiency of studies in IAWG. Dr Sargent responded that statistics for the number of comparisons are misleading, and that only the number of mandatory comparisons should be considered. Dr Milton then asked how participation in studies has changed over the years. Dr Sargent responded that the record cards summarize all results over the last 10 years. Dr May commented that most WGs have similar ways of tracking performance.

Dr May then initiated a discussion on the new proposed studies and began by asking why the IAWG is involved in the purity of salts and how far does the light shine in this area. Dr Sargent responded that measuring the purity of salts is important for calibration and traceability and HFTLS extends to the assays of these and a range of other salts, in addition to their calibration solutions. Dr Mester offered his support for the work on salt-based calibrants and asked if a guidance document on high purity salts was being developed as had been prepared for pure solid metals. Dr Sargent responded that nothing has been prepared yet, but that IAWG will work towards that. Dr May then concluded the discussion on proposed studies after hearing no additional concerns from members, and conditionally approved all proposed studies provided that Dr Sargent provides updated information for all studies including HFTLS statements.

10.9 CCQM WG on Gas Analysis (GAWG)

Dr Kim provided an update on the GAWG and began by noting that the meeting earlier in the week had been attended by 49 participants from 27 economies and the BIPM, NOAA and IAEA. He reported that there had been ten comparisons in 2016-2017, with three comparisons planned for 2018. Dr Kim then went on to describe the CCQM-K111 study on propane in nitrogen involving a number of RMO regional key comparisons, and noted that results have been published in the KCDB. Dr Kim reported that CCQM-K90 on formaldehyde in nitrogen to support air quality regulations was a technically challenging comparison because of the low concentrations involved and the extended stability testing required. Nevertheless, the recalculation of the KCRV by Dr. Antonio Possolo of NIST yielded similar results to the original BIPM calculations. The results of CCQM-K112 on biogas were presented, and Dr Kim noted that oxygen was problematic and that the WG agreed to use consensus values for the KCRVs for all components.

Dr Kim highlighted the comparisons that were due to have their measurement phase during 2017, including CCQM-K117 on ammonia in nitrogen, CCQM-K118 on hydrogen enriched natural gas, CCQM-K120a&b on ambient level CO_2, CCQM-K41.2017 on H_2S in nitrogen, CCQM-K137 on NO in nitrogen, and CCQM-K150 on particle number and charge concentration. He reported on the current status of CCQM-K117, noting that 50L aluminium cylinders with UN stamps are available with an estimated delivery time of five months, and the cost of these would need to be borne by participants. Requests for participation and purchase of the cylinder should be sent within the two

weeks following the meeting. Dr Kim continued with progress on CCQM-K118, noting that the next steps included data evaluation of candidate measurements, validation measurements by VSL/BAM, with dispatch of samples planned for August 2017. A timetable for CCQM-K120a&b was then presented, with the shipment of cylinders from the BIPM to participants planned after May 2017, reports on standard stability from participants due to BIPM in September 2017, and the Draft A report is planned for December 2017. Dr Kim provided some background information on CCQM-K150/P189, noting that aerosol particle number concentration has recently featured in vehicle emission legislation and is also important in atmospheric measurements. He then described condensation particle counters (CPCs) and that the standard ISO 27891:2015 describes a calibration procedure for CPCs, whereby NMIs can employ aerosol electrometers (AEs) for the calibration of CPCs. The comparison is designed to evaluate NMI comparability for airborne particle number concentration in the range (100 to 20 000) cm^{-3}, and airborne particle charge concentration in the range (0.15 to 3) $fC.cm^{-3}$.

Dr Kim reviewed the proposed studies beyond 2017, with CCQM-K74.2018 on NO_2 in nitrogen and CCQM-K10.2018 on BTEX planned for 2018. Studies planned for 2019 include CCQM-K3.2019 on automotive emission gases, CCQM-K26.b.2019 on sulphur dioxide in air, and CCQM-K68.2019 on nitrous oxide in air. Dr Kim continued by providing an update on the task group on ozone cross section, first established within GAWG in 2015. Statistical analysis of 14 published ozone cross-section values at 254 nm had been carried out by Dr Possolo using a DerSimonian-Laird model. Remaining tasks for the group included reviewing uncertainty budgets for published values and completing statistical analysis, archiving methodology and results in a peer-reviewed publication, and informing the GAWG regarding the recommended value for use in future BIPM.QM-K1 comparisons.

Dr May opened the discussion by commending the work of the task group and Dr Possolo within GAWG, noting that he is a NIST Fellow and Chief Statistician. Dr May also remarked that NOAA is a DI, designated by the World Meteorological Organization (WMO) as opposed to the US, therefore NOAA and NIST can participate in the same studies. A discussion on the new proposed studies ensued, beginning with CCQM-K150/P189 on aerosol particle number concentration. Dr Brown commented that this study is very important to the vehicle exhaust field, and that since particles are being counted the measurand needs to be clearly defined. He continued that the work is clearly related to gas analysis and relevant to the CCQM (there is no consultative committee for counting) and "1" will need to be included in the measurement unit – 1/m3. Dr Deleebeeck then inquired what particle concentration will be distributed, to which Dr Brown responded that the particles samples will be generated at the comparison location. After hearing no additional concerns from members, Dr May conditionally approved the CCQM-K150/P189 study provided that Dr Kim provides updated information including the HFTLS statement. Similarly, Dr May approved the CCQM-K137 study on NO in nitrogen. A short discussion then followed on the studies planned for 2018, which were repeats of previous studies. Dr Mester commented that repeating studies with changes in personnel is a good idea in some cases, but we cannot overlook our quality assurance systems and peer review processes that are intended to control for this. Dr May agreed and suggested that change in personnel should be only one factor used to decide when to repeat studies, so instead of repeating studies after a certain number of years, a number of factors should be considered before deciding when a study should be repeated. Dr Brewer added that for the new BTEX study para-xylene is also being separated, so this is adding new scope.

11. PROPOSED AD HOC WORKING GROUP ON ISOTOPE RATIO MEASUREMENTS

Dr Mester presented a proposal for a new initiative within CCQM on isotope ratio measurements. He began by highlighting the high-impact research fields that rely heavily on isotope ratio measurements, including the determination of the age of the solar system, estimating the Jurassic period climate, and measuring recent climate change. Dr Mester also discussed other practical applications of isotope ratio measurements, such as determining the origin of food or conflict diamonds, nuclear forensics, and the adulteration of pharmaceuticals. He continued by noting previous isotope ratio measurements for realizing fundamental constants, such as silicon isotopes for the Avogadro constant, silver for the Faraday constant, argon for the Boltzmann constant, and oxygen or hydrogen for the water triple point. Dr Mester reviewed the work of the NMI community for isotope ratio measurements implicated in revisions of atomic weights, notably BAM for cadmium and magnesium, LGC for carbon, NIM for selenium and ytterbium, NRC for mercury, germanium, and indium, and PTB for silicon. He described some of the challenges facing this area, noting that NMIs have invested heavily in isotope ratio measurements but there is limited coordination between them, with expertise spread across three or four WGs within the CCQM. Dr Mester pointed out differences and lack of coordination between the "light" and "heavy" isotope communities, noting that the light isotope field is anchored to CRMs without uncertainties and no traceability to the SI, while the heavy isotope filed is largely SI traceable. He also noted that the uncertainties are often significantly underestimated and that the mathematics of handling isotopic data is complex and impacts every discipline that uses mass spectral data.

Dr Mester continued by highlighting opportunities in this area for addressing stable isotope characterization in a systematic manner through:

- Building capacity in this field
- Coordinating and leveraging NMI and other stakeholder efforts
- Serving as a resource to other CCs and WGs facing challenges with either isotope related measurements or with associated data handling
- Bringing new scientific communities to the SI
- Firming up isotopic abundance/ atomic weight estimates for the most commonly measured elements
- Bringing stable isotope characterization under the SI.

Dr Mester concluded his presentation by proposing the establishment of an *ad hoc* working group tasked to develop the terms of reference and strategic plan for a stable isotope activity, to be presented to CCQM for consideration.

Dr May opened the discussion by proposing that a task force be created to build terms of reference and report by the next meeting on whether this is an appropriate activity for the CCQM, and if so, whether it should proceed as an *ad hoc* working group or directly to a full working group. He also noted that the task group should include at least one representative of each of the existing working groups with expertise in this field. The floor was then open for comments and Dr. Fajgelj began by pledging his support for this initiative and Dr Mester as its leader. Dr Brewer also offered support and noted that isotope ratio measurement issues are arising in the gas area. Dr May added that in addition

to the terms of reference, membership should also be considered since there is overlap with other WGs. Dr. Fajgelj asked whether the IAEA could provide a member to the task force and Dr May fully agreed, noting this would be a perfect role for a liaison. Dr Güttler also fully supported the initiative, and noted that PTB invested heavily in isotope ratio measurement for the Avogadro project. Dr Sargent offered his support and suggested the problem is greater than just SI traceability, but also with continuity and stability of the scale, and that the task force should encapsulate what goes on in the outside world and provide a timescale on how this group could tackle relevant problems. Dr Goren also pledged his support, noting that UME is building capacity in this area. Dr Li expressed support for this initiative as well, and encouraged other NMIs to develop CRMs in this area.

Dr May then closed the discussion by reconfirming that a task group be created and chaired by Dr Z Mester (NRC) to develop draft terms of reference for a dedicated group to deal with isotope ratio measurements within the CCQM.

12. REPORTS FROM RMOS

12.1 EURAMET

Dr Andres provided a report on the EURAMET technical committee for Metrology in Chemistry (TC-MC), consisting of 28 EURAMET member countries. The associate member JRC Geel (former JRC IRMM) terminated its associate membership at the end of 2016. National standards in chemistry or biology are held by 22 National Metrology Institutes (NMI) and 21 Designated Institutes (DI). The TC is comprised of four technical subcommittees (gas analysis, inorganic analysis, organic analysis, and electroanalysis). However, in response to the growing bio-metrology community within EURAMET the sub-committee on organic analysis will be renamed to encompass both bio and organic analysis. This name change will provide more visibility for the bio activities. Dr Andres listed a number of ongoing EURAMET comparisons, mostly in the gas analysis area, and highlighted other joint research activities that were taking place under the EMPIR programme. The next annual TC-MC meeting is scheduled from 5-9 February 2018, at BEV in Vienna, Austria.

12.2 SIM

Dr Cunha's report described recent activities in the SIM region. It reviewed the organization of SIM, noting that is it composed of five subregions (Noramet, Carimet, Camet, Andimet, and Suramet) from 34 countries in the Americas. Major achievements for the SIM chemical metrology working group (CMWG) since the last meeting were described, noting the region has experienced a strengthening in its chemical metrology activities, with more training sessions, interactions between NMIs, and an increase in the number of NMIs participating in regional and supplementary comparisons. An isotope dilution mass spectrometry (ID-MS) for clinical measurements course was described, which was provided by NIST in July 2016. It was designed to provide SIM NMI/DI laboratory personnel with in-depth classroom and hands-on laboratory experience in the ID-MS of clinical markers such as cholesterol, glucose and creatinine. Completed and ongoing comparisons in the region were highlighted, including propane in nitrogen, ethanol in aqueous matrices, synthetic natural gas, and

trace metals in drinking water. A comparison on automotive gas emissions in nitrogen is planned for the end of 2017. The new CMC claims submitted from the region were presented, where there were 159 in total with the majority coming Canada (79), Brazil (24), and Argentina (17). The presentation concluded with a review of challenges facing the SIM-CMWG, noting that there is a large gap in the state of development of NMIs, with a couple of mature NMIs, a few with intermediate level of development, and the majority at the developing or starting stage. This leads to a challenge in harmonizing needs and planning activities. The next SIM Chemical Metrology WG meeting will be held in Ottawa, Canada in September 2017.

12.3 AFRIMETS

Dr Botha gave an update on AFRIMETS stating that there were 45 members at the end of 2016. Dr Botha highlighted the increase in the number of Members of the BIPM and Associates of the CGPM across the continent over the last 10 years and there had also been an improvement in the level of scientific metrology of many countries during this period. She then reviewed highlights within AFRIMETS for 2016/2017, with 54 CMCs submitted for review from NMISA. The quality systems (QS) of NIS, NMISA, and KEBS were approved by the TC-QS, while the DEFNAT (Tunisia) QS was reviewed and non-conformances are currently being cleared. KEBS has submitted expansion of scope for approval. Ghana and Ethiopia are preparing to submit their QS for approval, while those of Namibia and Morocco are currently under review. Dr Botha then summarized the recent proficiency testing scheme operated in the region by NMISA and the African Food and Feed Reference Material Programme (AFFRMP) which was launched in 2015 and involved the training of analysts from less developed countries. Within the framework of the AFFRMP, a collaboration has been established with the BIPM and NIM China on capacity building for metrologically traceable mycotoxin reference materials for calibration, quality control and accuracy assessment. Dr Botha concluded her presentation by noting that NMISA will be hosting a mycotoxin metrology workshop in June 2018.

12.4 APMP

Dr Ma presented a summary of APMP TCQM activities. He began by reviewing the membership of APMP TCQM, with full members spanning across 24 economies (42 NMIs/DIs), with new members including Cambodia, Fiji, Nepal, Pakistan, and Papua New Guinea. Associate members are drawn from eight economies, with the USA (NIST) becoming an associate member in 2016, to become the APMP's 50th member institute. Dr Ma stated that 397 CMCs had been received and reviewed by APMP TCQM and 373 of these were subsequently submitted to the KCWG. This represented a significant increase from previous years, and he noted that they would be looking to decrease this in the future. Dr Ma then reviewed the recent meetings and workshops of APMP TCQM and noted that the 17th meeting would take place in New Delhi, India, in November 2017. Dr Ma presented the ongoing key comparisons and supplementary comparisons that are in progress within the region and the peer-review visits that had taken place within the region in the last year. He then reviewed an APEC Workshop on Measurement and Standards for Grain Food Safety, held in conjunction with the 16th meeting of the APMP TCQM in Da Nang, Viet Nam in November, 2016. The topic of the workshop was mycotoxins and heavy metal contamination in food, and was linked to the BIPM laboratory-based Capacity Building & Knowledge Transfer Programme (CBKT). Dr Ma then reviewed new comparisons and proposals, which focused exclusively on metrology for food safety

and climate change. Dr Ma concluded his presentation by summarizing MEDEA training projects under TCQM, focused on enabling developing economies in Asia.

Dr May offered his support for the structure of APMP and suggested it could be used as a model for other RMOs, where the primary focus is on capacity building and training.

12.5 COOMET

Dr Kustikov presented an update on COOMET TC 1.8 and reviewed the current membership, and noted the high rate of participation of COOMET in CCQM comparisons. He then reviewed the distribution of CMCs between NMIs and measurement categories, with 29 new CMCs over the past year primarily in gas analysis (12), advanced materials (nine), and high purity chemicals (six). Dr Kustikov listed current COOMET regional comparisons and presented results for studies on carbon monoxide in nitrogen, propane in nitrogen, pH measurement of phosphate buffer, moisture fraction in wood, and copper and impurities in the oxygen-free copper wire rod. Dr Kustikov concluded by noting that the next meeting of COOMET TC 1.8 "Physical chemistry" would be held in St Petersburg on 23-24 May 2017, and noted the celebration of the 175th anniversary of VNIIM in June 2017.

Dr Ma commented that APMP has sent information to COOMET and also AFRIMETS, as they are looking for collaboration.

13. BIPM PROGRAMME ON METROLOGY IN CHEMISTRY

Dr Wielgosz presented a progress report on the BIPM Chemistry Department. He began by highlighting the four major programmes within the department, all dedicated to the promotion of international equivalence of measurement standards. The programme included gas analysis for air quality and greenhouse gases, organic purity analysis for health, diagnostics, pharmaceutical, food, environmental and forensics, outreach activities with organizations such as JCTLM, IFCC, WADA, CODEX, etc.; and capacity building and knowledge transfer on areas such as mycotoxins and air quality. Dr Wielgosz then reviewed the organizational structure of the department, which currently consists of 10 FTEs. However, the department is heavily supplemented by visiting scientist secondments, which accounted for approximately 3.2 FTEs in 2016 and were expected to be seven FTEs in 2017. He thanked CCQM members for their support for the secondment programme.

Dr Wielgosz then summarized some of the recent outputs of the department and highlighted a subset of comparisons coordinated by the BIPM over the last three years and reported some of the results. CCQM-K55.d on the purity of folic acid highlighted the comparability between the qNMR and mass balance approaches to organic purity. Dr Wielgosz then reported on the results of CCQM-K115 on C-peptide, a marker used to differentiate between Type I and Type II diabetes, demonstrating the large number of impurities that had to be identified and quantified as part of the comparison. He then described work on assessing candidate materials for PAWG comparisons in collaboration with LGC, and highlighted metrological challenges of B-type natriuretic peptide measurements. Dr Wielgosz then provided an update on the qNMR universal calibrator project and described the calibration

hierarchy for BIPM qNMR internal standards, where $DMSO_2$ serves as the central compound with seven independent value assignments, three of which are direct from separate CRMs.

Dr Wielgosz discussed BIPM efforts in air quality and greenhouse gas standard comparisons, and highlighted the BIPM and NIST activities in updating the NIST Standard Reference Photometer (SRP) for ozone, where the refurbished electronics are expected to extend the lifetime of the instrument by 20 years. He described CCQM-K120 on ambient level CO_2., noting that as CO_2 mole fractions are being measured with such low uncertainty, isotopic composition of the CO_2 gas needs to be measured to correct for instrument response, and this had led to the development of CO_2 isotope ratio measurement capabilities at the BIPM. Preparation is underway for a CO_2 isotope ratio key comparison planned for 2020, with comparison samples being prepared at the BIPM and IAEA is assigning reference values.

Dr Wielgosz presented the BIPM's Capacity Building and Knowledge Transfer Programme (CBKT), developed in response to the needs expressed by AFRIMETS to support metrology infrastructure development for mycotoxin in food analysis requirements. A second meeting on mycotoxin metrology within the CBKT project took place on 21 April 2017. Work is being carried out in three main areas, namely knowledge transfer on mycotoxin calibrant production and value assignment at the BIPM, analytical method development at NMISA, and matrix CRM development at NIM. A series of skills broadening and training secondments have been established at the BIPM, consisting of 12-week programmes on the preparation of stock and calibrations solutions, stability and homogeneity testing, and value assignment. He reminded the CCQM that the CBKT programme was funded through additional voluntary funds, and thanked the NMIs that had supported the programme, and in particular NIM, China, that was providing three man years of visiting scientist time at the BIPM, as well as the mycotoxin materials for the programme, and the PTB, that had provided funding to allow scientists from INTI, INMETRO, KEBS and NIMT to participate in the programme.

Also within the framework of the CBKT programme, Dr Wielgosz presented on the "Metrology for Clear Air – Gas Metrology & FTIR" project, where NMIs developing gas metrology capabilities and standards require measurement techniques that can operate at low uncertainties to verify and value assign their standards. FTIR provides a cost effective and accurate solution for NMIs, but requires expert knowledge for operation and data analysis. Similar to the mycotoxins project, a series of secondments at the BIPM have been established to facilitate knowledge transfer in this area. The first of these from CENAM (Mexico) was funded by the PTB (Germany) and three more (involving scientists from NMISA (South Africa) and NPLI (India) are being funded by the NPL (UK). In response to a question from Dr Wielgosz regarding comparisons on mycotoxin calibration solution that were part of the BIPM CBKT programme, Dr May replied that these should be registered as CCQM comparisons via the CCQM Organic Analysis Working Group.

Dr Wielgosz concluded by highlighting a BIPM-WADA Workshop on NMI support for anti-doping analysis. The workshop was attended by over 100 participants from NMIs, national anti-doping laboratories, and clinical chemistry laboratories. A series of recommendations resulted from the workshop, including the commitment to develop a prioritized list of CRMs required for anti-doping analysis.

14. DISCUSSION AND APPROVAL OF PROPOSED CCQM STUDIES

Dr May initiated a discussion on proposed CCQM studies on the opening of the second day of the meeting, based on a list of studies collected after the first day. For the WG chairs that presented on the second day (OAWG, IAWG, GAWG), the discussion on approval of proposed studies took place following their respective reports, and these discussions were captured accordingly above. There were no new key comparisons proposed within NAWG, CAWG, and EAWG (two pilot studies), however, PAWG proposed one new KC on quantification of insulin and SAWG proposed studies on BET surface area and a comparison related to CCQM-K32 on thickness measurement of HfO_2.

The discussion began with the proposed PAWG study on quantification of insulin and Dr Park described the study involving pure synthetic insulin in a buffer solution, underpinning core capabilities for quantification of ~ 5kDa proteins by hydrolysis/amino acid analysis method and/or intrinsic sulphur determination. Dr May suggested that since hydrolysis is the core competency, the HFTLS statement should reflect this and the title should be changed to focus on hydrolysis. Ms Parkes added that since hydrolysis is an underpinning core competency, that it needs to be defined with a specific mass range. Dr Park added that there are so many different types of proteins that we need to look at representative proteins and work on a series. Dr May then proposed that the insulin KC should be provisionally approved, but Drs Park, Wielgosz, May, and Botha need to agree on the HFTLS statement to be sent out with the action items of the meeting. Dr Wielgosz then reminded WG chairs that as part of the study approval process, the form used by the KCWG requires completion and will allow a number to be assigned to the comparison, and the HFTLS statements should already be developed at this time. Dr Wielgosz then inquired if the additional studies planned within PAWG required presentation at this time, such as proposed purity studies for oxytocin, haemoglobin A1c (HbA1c), and haemoglobin A0 (HbA0), which are under way and further along than the insulin study. Dr Mackay noted that these studies have also been discussed extensively within OAWG. Dr Park responded that it was his understanding that these studies had already been approved since they had been given a study number. Dr May then confirmed that the CCQM study approval process will not be applied retroactively, so all studies previously approved during strategic planning will be considered pre-approved.

The two proposed studies within SAWG were then discussed, starting with the Brunauer, Emmett and Teller (BET) method study. Dr Unger described the study using the BET method for surface area, specific pore volume, and pore diameter in a microporous white quartz sand (SiO_2), with seven NMIs have expressed interest for supporting their services delivered such as reference methods, proficiency testing schemes, and CRMs. Dr May opened the discussion by reviewing that BET surface area is the measurand, with the convention laid out by ISO standards. Dr Brown remarked that the traceable measurand is the amount of nitrogen absorbed. Dr Mester then asked that if we are following an ISO procedure very closely, are we proving the appropriate feedback to ISO. Dr Unger confirmed they were not but will consider that moving forward. Dr May then commented that we need to consider whether it is our job to critically evaluate another organization's method without their permission. Dr Emons noted that there is no doubt of the importance of these measurements, but pore diameter is not a parameter of the CCQM, and might fall under another CC. Dr May then reaffirmed that the measurand is the amount of nitrogen absorbed per unit mass, and confirmed the study should be provisionally approved, but Dr Unger is to provide a clear definition for the study and provide the number of committed labs, and Drs Unger, Wielgosz, May, and Botha need to agree on the HFTLS statement.

Dr Unger then proposed a study related to CCQM-K32, on the thickness measurement of nanoscale HfO_2 films on a Si wafer, suggesting that technology has developed since the original study and eight NMIs are interested. Dr May asked whether this is a repeat or different comparison. Dr Unger confirmed that it will study a different sample using the same method. Dr Sargent then asked why the change from SiO_2 to HfO_2 and Dr Unger answered that this is due to response from industry, where they are less interested in SiO_2. Ms Parris commented that if the study underpins an expanded capability, then it should have a new study number. Dr Mester inquired if reporting on length will be in conflict with the CCL, to which Dr Milton responded that the work needs to be carried out by the group with the expertise, which is clearly in SAWG and not in CCL. Dr May then confirmed the study should be provisionally approved, but that Dr Unger is to provide an updated title and HFTLS statement to Drs Wielgosz, May, and Botha.

Dr May confirmed that in going forward, new CCQM comparisons would be formally approved by the CCQM, with CCQM WG Chairs presenting the comparisons planned for the next three year period, allowing NMIs sufficient time to allocate resources. For each comparison submitted for approval, it should be made clear how the comparison fits into the CCQM strategic plan, and that a How Far the Light Shines Statement has been developed and the number of expected participants is known.

15. COMMENTS ON WRITTEN REPORTS FROM INTERNATIONAL ORGANIZATION IN LIAISON WITH THE CCQM: REPORT FROM THE JCTLM

Dr Wielgosz gave a brief update on the recent activities of the JCTLM. He reminded members that the JCTLM database was developed to help the *in vitro* diagnostics (IVD) industry meet metrological traceability requirements of the EU IVD Directive, and that BIPM provided the Secretariat for JCTLM. Dr Wielgosz described work of the JCTLM Working Group on Traceability: Education and Promotion (JCTLM-TEP WG) and the establishment of a new traceability website (http://www.jctlm.org) to be operated and maintained by IFCC and populated with the WG-TEP output. He then summarized a joint NIM-BIPM workshop held in Chengdu, China, on 1-3 June 2016, on Protein and Peptide Therapeutics and Diagnostics, which showcased 70 presentations and drew over 450 participants. Dr Wielgosz concluded his update by raising an issue prompted by JCTLM database users, who have requested that information from international CRM producers in the database should be provided in English. He noted that the CIPM MRA does not require this, but that international users are requesting this. Dr May noted the point, but reaffirmed that this was not a CCQM issue.

16. FUTURE CCQM WORKSHOPS

As described above, Dr May urged the CCQM to dedicate more time for workshops related to improving measurement science and standards, and suggested that the proposed third day of the CCQM plenary could be an ideal venue for such as workshop.

17. CCQM RESOLUTIONS

There were no resolutions made during the meeting.

18. ANY OTHER BUSINESS

Dr Botha took the opportunity to point out that ILAC made decision for a 3-year implementation period for ISO 17034, and that ISO Guide 35 has also been finalized and should be published in the next few months.

19. DATES FOR CCQM WG MEETINGS TO BE HELD DURING THE 2ND HALF OF 2017

It was determined that fall WG meetings for CAWG, NAWG, OAWG, PAWG, will be held at NRC in Ottawa, Canada, on 27-29 September 2017. The IAWG meeting will be held at INRIM in Turin, Italy, on 26-28 September 2017.

20. DATES FOR THE NEXT MEETING OF THE CCQM

The next meetings of the CCQM Working Groups will take place from 16-18 April 2018 (KCWG on 14-15 April 2018), with the 24th meeting of the CCQM taking place on the 19-20 April 2018.

Dates and locations for CCQM WGs in the fall of 2018 were discussed. The CCQM thanked the various NMIs for their offer to host meetings. The locations and provisional dates for meetings were agreed: OAWG, PAWG, NAWG and CAWG meetings to be held in Chengdu, China, hosted by NIM (8-9 October 2018); GAWG meeting to be held in Queretaro, Mexico, hosted by CENAM (8-9 October 2018); IAWG to be held in Ottawa, Canada hosted by NRC (Fall 2018).

21. CLOSURE

In the absence of any other business, the President of the CCQM, Dr May, closed the meeting at 16:00 hrs and thanked participants for their contributions, reports and participation in the discussions.

Dr May thanked the staff of the BIPM for their support in hosting the meeting and wished all attendees a safe journey home.

Dr J. E. Melanson

Rapporteur, 4 July 2017

DECISIONS AND ACTIONS FROM THE 23RD MEETING OF THE CCQM

1. Dr Melanson agreed to serve as rapporteur and draft "Decisions and Actions" document and "Report of 23rd Meeting of the CCQM". Based on a request from the President, he agreed to serve in this capacity through 2018.
2. CCQM approved the report of the 22nd Meeting of the CCQM.
3. Outstanding actions from the 22nd Meeting of the CCQM to be progressed as discussed in the report of the 23rd Meeting of the CCQM.
4. KCWG to continue to work to implement a unified nomenclature for the core comparison approaches being undertaken by different WGs to avoid confusion when communicating outside the CCQM.
5. Regional Metrology Organizations (RMOs) will be requested to submit reports at least four weeks prior to the CCQM April meeting to enable discussion and questions on any issues arising.
6. No consensus was reached on the proposal from the CCQM *ad hoc* WG on KCDB2.0 to remove several columns from the current CMC template.
7. Going forward, CCQM attendees should define CCQM-specific acronyms they are using throughout presentations and discussions for the benefit of guests and stakeholders.
8. The CMC review activity formerly undertaken by the BioCMC group will be undertaken by the concerned individual WGs (NAWG, PAWG and CAWG) for the upcoming round of CMC reviews. The NAWG, PAWG, and CAWG Chairs will work with the KCWG in documenting the process to be used for biological CMC review in future years.
9. The CCQM President established a Task Group to be chaired by Dr Andres (METAS) to develop a position paper describing the criteria used to decide which method-defined measurands and measurement services were in the scope of activities covered by the CCQM. The following agreed to contribute to the work of the task group: Dr Brown, Dr Ellison, Dr Emons, Dr Güttler, Dr Li, Dr Mester, and Dr Morrow, and Dr Wielgosz.
10. The name of the EAWG will be changed to the Working Group on Electrochemical Analysis and Classical Chemical Methods and its terms of reference are to be updated accordingly.
11. New CCQM comparisons shall be formally approved by the CCQM, with CCQM WG Chairs presenting the comparisons planned for the next three year period, allowing NMIs sufficient time to allocate resources. For each comparison submitted for approval, it should be made clear how the comparison fits into the CCQM strategic plan, and that a How Far the Light Shines Statement has been developed and the number of expected participants is known.
12. The CCQM President confirmed that the CCQM study approval process will not be applied retroactively, so all studies previously approved during strategic planning will be considered pre-approved.
13. The CCQM President established a task group to be chaired by Dr Mester (NRC) to develop draft terms of reference for a dedicated group to deal with isotope ratio measurements within the CCQM, and if so, whether it should proceed as an *ad hoc* working group or directly to a

full WG. The task group should include at least one representative of each of the existing working groups with expertise in this field.

14. The CCQM agreed to submit the following proposed wording for the definition of the mole for consideration by the CCU: "The amount of substance, symbol *n*, of a system is a measure of the number of specified elementary entities. An elementary entity may be an atom, a molecule, an ion, an electron, any other particle or specified group of particles. The mole, symbol mol, is the SI unit of amount of substance. One mole contains exactly 6.022 140 8Y × 10^{23} elementary entities. This number is called the Avogadro number and is the fixed numerical value of the Avogadro constant when expressed in the unit mol^{-1}."

15. The CCQM President appointed a team (M. Mariassy (Chair), A. Botha, R. Parris, and R.I. Wielgosz) to review the application received from VNIIFTRI for CCQM Member/Observer Status. The review team will proceed by a paper-based review of the documentation submitted to support the application, and report back to the President with a recommendation, including whether further information is required in order to produce a recommendation.

16. To bring levels of CCQM information on the BIPM website in line with other CCs, the CCQM will develop guidelines for increasing open access documents while protecting sensitive information. Dr R. Wielgosz will draft guidelines for discussion by SPWG.

17. The CCQM draft strategy document will be revised by the CCQM Executive Secretary based on comments received during the CCQM Workshop and plenary session, including restructuring sections of the document according to the three major objectives of Consultative Committees (progressing the state of the art of measurement science; reaching out to new and established stakeholders; and demonstrating the global comparability of measurements) with circulation of the revised draft for final comment in July 2017.

18. The CCQM WG Chairs were requested to provide case studies, when available, on impact of CCQM activities for inclusion in the CCQM Strategy document.

19. It was decided that the mycotoxin calibration solution comparisons being coordinated by the BIPM as part of its Capacity Building and Knowledge Transfer Programme could be registered as CCQM comparisons via the CCQM Organic Analysis Working Group.

20. The President expressed his interest in establishing a "Young Chemical Metrologist Award". Details to be provided and discussed.

21. The CCQM will not request an exception related to the issues of overlapping CMCs from one country. Drs May, Mackay, Milton and Wielgosz will discuss and propose a solution to be discussed and agreed upon by the SPWG.