Bureau International des Poids et Mesures

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

Report of the 21st meeting
(20-21 April 2015)
to the International Committee for Weights and Measures

Comité international des poids et mesures

Note:

Following a decision of the International Committee for Weights and Measures at its 92nd meeting (October 2003), reports of meetings of the Consultative Committees are now published only on the BIPM website and in the form presented here.

Full bilingual versions in French and English are no longer published.

M. Milton
Director BIPM

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

as of 20 April 2015

President

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

National Institute of Standards and Technology, NIST, Gaithersburg

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.

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.

Institute for Reference Materials and Measurements [IRMM].

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

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].

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.

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

SP Technical Research Institute of Sweden [SP], Borås

State Laboratory [SL], Co. Kildare.

VSL [VSL], Delft.

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.

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

Hong Kong Government Laboratory [GLHK], Kowloon.

Hungarian Trade Licensing Office [MKEH], Budapest.

Instituto Português da Qualidade [IPQ], Caparica

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

National Physical Laboratory of Israel [INPL], Jerusalem.

1. OPENING OF THE MEETING

The Consultative Committee for Amount of Substance: Metrology in Chemistry and Biology (CCQM)* held its nineteenth meeting at the International Bureau of Weights of Measures (BIPM), at Sèvres on 20-21 April 2015.

The following were present: M. Adeogun (NPL), H. Andres (METAS), A. Botha (NMISA), P. Brewer (NPL), R.J.C. Brown (NPL), G. Carroll (SL), D. Craston (LGC Ltd), H. Emons (IRMM, ISO REMCO), A. Fajgelj (IAEA), P. Fisicaro (LNE), T. Fujimoto (NMIJ/AIST), A.C. Gören (UME), B. Güttler (PTB), A. Hioki (NMIJ/AIST), W. Hongthani (NIMT), E. Hwang (KRISS), P.T. Jakobsen, (DFM), J.S. Kim (KRISS), S.K Kim (KRISS), Y. Kustikov (VNIIM), T.K. Lee (HSA), H. Li (NIM), L. Locascio (NIST), L. Ma (NIM), L. Mackay (NMIA), B. Magnusson (SP), M. Máriássy (SMU), W.E. May (President of the CCQM), P. McCarron (NRC), Z. Mester (NRC), J. Morrow (NIST), U. Panne (BAM), S.-R. Park (KRISS), H. Parkes (LGC Ltd), A. Pérez-Castonena (CENAM), A.M. Rossi (INRIM), M. Sargent (LGC Ltd), M.P. Sassi (INRIM), M. Sega (INRIM), P. Silva (NIMT), T.L. Teo (HSA), P. Unger (BAM), A. van der Veen (VSL), S. Vaslin-Reimann (LNE), R.L. Watters (NIST).

Observers: P.K. Gupta (NPLI), W. Kozlowski (GUM), L. Samuel (MSL), D. Wai Mei Sin (GLHK), Z. N. Szilágyi (MKEH), T.F. Vicente (CEM).

Invited: M. Buzoianu (INM), P.A. Gatti (INTI), H. Klich (INRAP), K. Koech (KEBS), D. Moturi (KEBS), R. Parris (NIST), V. Ponçano (REMESP), O. Zakaria (NML-SIRIM).

Also present: R. Kaarls (CCQM Past President), S. Maniguet (BIPM), M.J.T Milton (Director of the BIPM), P. Moussay (BIPM), D. Olson (BIPM), R. Wielgosz (Executive Secretary of the CCQM, BIPM).

Sent regrets: Dr L. Siekmann (Universitätsklinikum – Bonn)

Dr May, the President of the CCQM, officially opened the 21st meeting of the CCQM at 0900 hrs on the morning of 20 April 2015. Dr May initiated a round table self-introduction by all participants and observers.

2. OPENING REMARKS BY THE CCQM PRESIDENT

Dr May gave a summary of the status of the CCQM. He thanked all members for their hard work over the last year which had contributed to the success of the CCQM. He noted that unquestionably the work of the CCQM had enabled NMIs to identify areas of excellence within the chemical and biological measurement world that have led to the establishment of strategic collaborations for both research and standards development purposes. This has also improved the quality of chemical and biological measurements within the world-wide NMI community, which has led to better (more and higher quality) services for end users. Dr May noted that the CCQM was the most active of the CCs;

* For the list of acronyms, click here.

currently there are 28 member organizations and 12 observer organizations. The eight Standing Working Groups and three *ad hoc* Working Groups are attended by over 200 experts from NMIs and other expert institutes. It was noted that the yearly CCQM plenary meeting was attended by approximately 70 representatives from member and observer institutes, stakeholder organizations and guests. Dr May remarked on the large number of CMCs in the chemistry and biology area: currently over 5700 CMCs for 830 different analytes with 3050 different analyte-matrix combinations. The number of analyte-matrix combinations is increasing at a rate of about 250 per year. To date the CCQM has completed 365 comparisons (187 Key Comparisons and 178 Pilot Studies) with 25 currently under way including the first two comparisons on microbial identity and cell counting.

Dr May then expanded on the changes that have been made to the structure of the CCQM. Dr May stated that he wanted to wait until after the re-election of the CIPM and his re-appointment as CCQM President to make these changes. The main changes have been to sub-divide the Working Group on Bioanalysis (BAWG) into discipline-based Working Groups (WGs), namely: a Nucleic Acid WG, a Protein Analysis WG and a Cell Analysis WG. It was stated that the *ad hoc* Steering Group on Microbial Measurements (MBSG) will continue to operate for the immediate future and any possible overlaps with the new WGs in the bioanalysis area will be assessed in due course. The Chairs of the successor WGs to the BAWG were named. These are Mrs Parkes (LGC) for the Nucleic Acids WG, Dr Plant (NIST) for the Cells WG and Dr Park (KRISS) for the Proteins WG. The deputy WG chairs for these new groups would be announced in due course following discussions with the new WG chairs. Dr May welcomed the diversity of the new chairs coming from three different RMOs, but stated that he was also keen in future to see more representation from COOMET and AFRIMETS in the WG chair and deputy chair structure.

Dr May then reflected on the original reasons for the CIPM MRA, in particular that it "was established in 1999 in response to a growing need for an open, transparent and comprehensive scheme to give users reliable quantitative information on the comparability of national metrology services and to provide the technical basis for wider agreements negotiated for international trade, commerce and regulatory affairs." Moreover, it was noted that this arrangement requires the declaration and documenting of calibration and measurement capabilities (CMCs), evidence of successful participation in formal, relevant international comparisons, and demonstration of systems for assuring quality of each NMI's measurement services – often delivered by peer review visits. He noted that the continuing increase in the number of these comparison studies, the CMCs that they produce and the effort required to underpin this is not sustainable and also that it does not allow sufficient time for scientific discussions. Dr May also stated that he did not feel the whole process included sufficient stakeholder engagement. To address these challenges Dr May outlined the activities that the CCQM was undertaking and planned to undertake in the future. These actions included: establishing a strategic planning framework for key comparisons, examining the basis and structure for CMCs under the *ad hoc* WG on CMCs, and sub-dividing the Working Group on Bioanalysis. Dr May also mentioned the planned symposium on "Chemistry and the International System of Weights and Measures" at the American Chemical Society (ACS) National Meeting to be held in Boston, USA, on 19 August 2015, which was a key part of engaging more effectively with stakeholders. If successful, Dr May stated that he would like to see similar seminars replicated at other chemical society meetings within other RMOs. It was also noted that the CCQM *ad hoc* WG on CMCs was part of a wider CIPM effort to review the CIPM MRA and he mentioned the CIPM MRA Review Workshop to be held at the BIPM on 13-14 October 2015. Dr May welcomed suggestions for key users of chemical and biological CMCs to contribute to the meeting and further speculated that it might be useful to have a separate user panel at the meeting solely for chemical and biological services at NMIs.

Dr May concluded his introduction by highlighting the two CIPM meetings and one CGPM meeting that had taken place since the last CCQM meeting in April 2014. Dr Milton recalled the resolutions of the CGPM and stated that these were available on the BIPM website. In particular Dr Milton discussed the resolutions of particular relevance to the CCQM: 'On the future revision of the International System of Units, the SI', 'Dotation of the BIPM for the years 2016 to 2019' and 'On the importance of the CIPM Mutual Recognition Arrangement', noting the continuing encouragement from the CGPM for review of the MRA. Whilst recognizing that there was no increase in the dotation to the BIPM up to 2019, Dr Milton nonetheless noted that there would be a need for the BIPM to move into new areas of work, in particular to recognize that new Member States do not always have a full metrology infrastructure in place and the need to help them develop in this respect. As such Dr Milton invited all NMIs to work with the BIPM to develop suitable capacity building and knowledge transfer activities. Dr May also reported that the traceability exception on the delta scale for isotope ratio measurements proposed by the CCQM had been accepted by the CIPM with minor modifications.

3. APPOINTMENT OF A RAPPORTEUR

Dr May proposed Dr Brown as the rapporteur for the meeting; Dr Brown agreed. Dr May took the opportunity to congratulate Dr Brown on his recent election as an NPL Fellow.

4. APPROVAL OF THE AGENDA

The agenda was accepted with an alteration to allow the chairpersons of the new working groups in the bioanalysis area to give brief introductory presentations under item 9.

5. REPORT OF THE 20TH MEETING OF THE CCQM

Dr May thanked Dr Brown, rapporteur for the twentieth meeting of the CCQM, for producing the meeting report. Dr Wielgosz reported on the progress with decisions and actions arising from the 20th meeting of the CCQM that were included at the end of the report. The following actions were still in progress:

- Dr Kaarls to produce a first draft of a document describing the history of the CCQM.
- The KCWG to consider unified nomenclature for the core comparison approaches being undertaken by different WGs to avoid confusion when communicating outside the CCQM.

In addition the following decisions and actions had been undertaken, superseding previously recorded decisions:

- The invitation of the chairman of VAMAS to the CCQM had been superseded by a joint CIPM-VAMAS initiative to hold a workshop in June 2016 entitled "New Measurement Challenges in Materials Metrology".
- CCQM WG meetings will continue to be hosted once a year at the BIPM for the time being.

Dr Wielgosz reminded participants that CCQM-F-01 (previously CCQM/14-09), which is the required form for guest laboratories to participate in CCQM studies, is approved and must be used where applicable. He further noted that the KCWG system of nomenclature for the numbering of CCQM studies to unambiguously distinguish between subsequent comparisons, repeat comparisons, multiple-analytes, and multi-part comparisons conducted over a period of time had been agreed and should be adopted. Dr Wielgosz then discussed the publication of study and comparison results and emphasized that for pilot studies the coordinating laboratory had the first option on publishing data, and required agreement from participating laboratories for their data to be published.

The CCQM approved the report of the 20th Meeting of the CCQM.

6. OUTCOMES OF THE 25TH MEETING OF THE CGPM AND THE OCTOBER 2014 AND MARCH 2015 MEETINGS OF THE CIPM

Dr May stated that he has presented what he wished to say under agenda item 2. There were no further questions.

7. ORGANIZATION OF THE CCQM AND LEADERSHIP OF CCQM WORKING GROUPS

Dr May reiterated the changes that had been made to the structure of the CCQM WGs that were presented under agenda item 2. It was also noted that there were no changes to the chairs and vice-chairs of the existing CCQM WGs. The new WG and leadership structure was approved by the CCQM.

8. UPDATE ON THE CCQM STRATEGIC PLANNING DOCUMENT

Dr Wielgosz gave an update on the CCQM strategic planning document. This covered the current strategy document from 2013-2023 and the future update which will cover the period from 2017-2027. Dr Wielgosz stated that the list of comparisons continues to be updated and a part of the review of the strategy will be to compare the number of comparisons that the CCQM planned to

conduct against what was actually delivered. Dr Wielgosz noted that the revised strategy document would need to be ready in 2017 in time for the CGPM meeting in 2018, and he subsequently elaborated on two timelines which would develop these strategies over a one year or two year timeframe.

At this stage Prof. Emons noted that the review of planned comparisons against what was actually carried out might not be reasonable if the focus and structure of CMC claims is changing in the meantime; further he mentioned the forthcoming CIPM MRA workshop and wondered how much effort should be expended prior to this if the structures of the CMC process are likely to change. Dr Wielgosz noted that the new CCQM WGs have a very limited number of CMCs currently so this would not be a problem for them. For the established CCQM WGs, he stated that if the one year time frame for review and revision of their strategy documents was chosen, this would mean it would start after the review meeting on the CIPM MRA and could take into consideration the outcomes of this meeting and follow on actions. He went on to state that the CCQM *ad hoc* WG on CMCs would be providing strong input into the CIPM MRA workshop. Dr Milton confirmed that the CCQM input to the process had been very useful so far and that the timings proposed are suitable to receive appropriate steer from the CIPM MRA workshop. It was proposed that the newly created CCQM WGs will work to update their strategy according to the proposed two year timeline whilst existing CCQM WGs will work to update their strategy for the proposed one year timeline. The CCQM agreed to this proposal.

Dr May suggested that this would be a good opportunity for a broader discussion of the CIPM MRA workshop, which he had previously introduced in agenda item 2. He reiterated the need to have active participation from users and stakeholders and asked the CCQM for suggestions to get better representation of the chemistry community. Dr Fajgelj expressed concern that the International Atomic Energy Agency (IAEA) was currently listed in the programme as a user of the database where it is in fact a signatory to the CIPM MRA and a contributor to the KCDB. Dr May acknowledged this and will pass on this comment to the organizers. Prof. Emons expressed the opinion that inviting users was a very good approach, but suggested that the International Laboratory Accreditation Cooperation (ILAC) is also not a user, but is part of a different category of interested party. He suggested an approach where users from different groupings are invited, for instance: application areas, regulators, accreditors and industrial sectors. Prof. Emons also mentioned the need to cover the international trade perspective. Dr Fajgelj expressed support for this idea and wondered if another grouping of international organizations such as the IAEA, World Meteorological Organization (WMO), European Space Agency (ESA) and others could provide useful input. Dr Wielgosz presented a summary of the discussions from the CCQM Strategic Planning WG which had taken place the previous day. In particular four sectors were highlighted for the user panel in chemistry, which would be in addition to another panel on physical measurement. The suggestions were: a gas industry representative (because of the large number of gas CMCs), a healthcare representative (which would also link to a discussion of the JCTLM), a representative from the global analytical service provider community, and a large chemical producer. Dr Watters asked whether the discussion was informed by the recent report on who was using the database. Dr Wielgosz replied that whilst the general background of visitors was known from the survey there were no specific names that could be used. Dr May was concerned that the needs of the developing world had not been fully considered. Dr Sassi suggested representation from the biomedical industry. Dr May stated that if an appropriate name could be identified then this would be a sensible suggestion. He elaborated, that this sector could provide information about what sort of data would be useful to populate the KCDB and further what information might be needed in future for these sectors where the metrology needs are only starting to be understood.

9. REPORTS FROM CCQM WORKING GROUPS

The reports from the CCQM WGs began with a brief introduction to the newly formed working groups in the bioanalysis area by the new chairpersons.

9.1. Cell Analysis WG (CAWG)

Dr Plant introduced the proposed terms of reference of the new WG, namely: To establish global comparability of cell measurements through bioanalytical reference measurement systems of the highest possible metrological order, to develop and validate measurement systems through pilot studies and key comparisons prioritized in response to end-users (e.g. clinical, pharmaceutical, food) and regulators, to ensure studies are driven by end-user requirements, and to integrate activities with international stakeholders (e.g. the World Health Organization (WHO), Joint Committee for Traceability in Laboratory Medicine (JCTLM), International Organization for Standardization (ISO)).

Dr Plant further elaborated on the scope of the group. She proposed that cell analysis will include measurements of composition or function of intact cells that are the result of emergent behaviour. Relevant measurements include identification and quantification of cell number or cell components (e.g. cell surface receptors, *in situ* genes or proteins), and measures of biological response or function (e.g. morphology, secretion of factor, expression rate of one or more genes) in the context of cell emergent behaviour. Measurements of genetics, genomics, transcriptomics, metabolomics and proteomics may be required to achieve measurement of the emergent behaviour, and could be undertaken in collaboration with other WGs. Dr Plant noted that the measurand may not be easily defined. She reiterated that validating the relevance of the measurand is critical to end-user application and that the immaturity of the metrology of cell measurements requires a step-wise approach.

Dr Plant highlighted the key action items for the WG were to name a co-chair, assess measurement services provided by NMIs (to inform need for CMCs), develop a consensus scope, and develop a strategy. A number of pilot studies that had been completed or were in progress under the BAWG were highlighted as being relevant to the new WG (CCQM-P102, CCQM-P123, CCQM-P165).

Prof. Emons stated that the move into the cell area was now clearly introducing functional properties and method defined measurands. Further, he stated that understanding the difference between what you intend to measure and what was actually measured in such an area is key. Prof. Emons questioned how such difficulties would be captured in CMCs. Dr Wielgosz asked which quantities and properties were going to be covered by the working group – for instance, cell number count, cell size, cell shape, cell activity, and which reference systems were NMIs providing in these areas that would be the focus of comparison studies? Dr Plant agreed that this was a new area where there was little metrology currently and that this would be a priority to define. For example another measurand could be what the cell is secreting. Dr Locascio wondered whether the group would be restricting itself to particular cell types. Dr Plant replied that she did not think so at this stage but that is very much dependent on what was of use to end users. Mrs Parkes suggested that biobanks would likely be interested in the work of the new group. Prof. Emons reminded the CCQM of the difficultly in unifying safety and ethical considerations across the global community when conducting work on biological material and that this may impact on the work of the group in the future.

Dr May concluded the discussion by asking what a successful outcome for the group would be after 5 years. Dr Plant replied that she hoped that by this time NMIs would be interacting properly with the user community and supporting a sub-set of assays that are of use.

9.2. Protein Analysis WG (PAWG)

Dr Park introduced the Protein Analysis WG. He stated that the mission of the WG would be to deliver comparisons to support the CIPM MRA, perform group studies on areas where there are technical challenges, and develop a forum for exchanging information among stakeholders. He further elaborated that the scope for the WG would include all critical issues in protein measurements (quantitative and qualitative analysis, structure, activity, protein interaction). It was stated that this was likely to include close cooperation with the OAWG on amino acids and peptides, and cooperation with the NAWG or CAWG on protein expression, function, and identification. Dr Park proposed that the initial activities of the group would be: to establish metrology core components of protein measurements (some of which are already being undertaken in ongoing BAWG comparisons), to promote development of advanced techniques and innovative measurement, to address special issues with protein certified reference materials (CRMs) (stability and commutability), to provide solutions to critical problems in the protein measurement field and to set priorities that reflect the demands and capabilities of end users. In particular it was stated that protein activity measurement is a critical issue for the user community that needs to be correlated with more traditional quantities. Dr Park concluded by stating that the expected outcomes of the group would be protein quantification systems for SI-traceable quantity values, a substantial number of reliable CRMs as well as a number of successful CMC claims, and high impact publications on relevant metrology topics by the working group members.

Dr May opened the discussion by considering whether it might be necessary to expand the membership to include stakeholders in order to make the group more relevant. He also stated his desire that the WG should have membership from NMIs with active metrology programmes in the area and should not simply be a discussion forum or collective research programme. Dr May asked what a successful outcome for the group would be after 5 years. Dr Park replied that he would see success as a resolution of the current lack of agreement in fundamental protein measurements and to produce a roadmap for longer term goals. Dr Sargent further remarked that in the area of metallo-proteins there may be opportunities for collaboration with the IAWG. Prof. Emons cautioned that there remained a need to identify relevant measurands otherwise the work could drift towards those that that are easy to define but not as relevant to end users. At this stage Dr Liandi stated that biology is a very wide field and includes both bio-physical and bio-chemical measurements. Whilst agreeing, Dr May replied that the name of the CCQM has only just changed and is unlikely to change again soon and, moreover, we are only starting to define what actually constitutes metrology in biology. Dr Goren asked whether there was currently any traceability for structure measurements. Dr Park replied that this was currently lacking and that it was the role of the new group to address the gap between structure and function. Dr Plant added that stakeholders want information on both protein activity (which is related to biology) and protein structure (which is related to biochemistry). Dr Park stated that the group would start with biochemistry before starting to address the more biological aspects.

9.3. Nucleic Acid WG (NAWG)

Mrs Parkes introduced the new Nucleic Acid WG. She stated that the responsibilities of the NAWG are: to establish global comparability through nucleic acid reference measurement systems of the highest possible metrological order, to carry out key comparisons and where necessary pilot studies, to critically evaluate NMI/DI claimed competences for measurement standards and capabilities for nucleic acid analysis and to integrate NAWG activity with that of international stakeholders such as the WHO, CODEX Alimentarius and JCTLM in order to harmonize nucleic acid reference measurement systems. Further, Mrs Parkes elaborated that the measurement scope of the group included, but was not limited to, chromosomes, DNA, nucleotides, oligonucleotides, modified DNA (e.g. DNA methylation and other epigenetic modifications), mRNA, miRNA and other short non-coding RNAs) in a biological measurement context. In addition the identification and quantification of nucleic acids in complex matrices (such as those derived from plant, animal and microbial origins) was also included. Mrs Parkes then elaborated on the NAWG measurement space, in particular, highlighting the chromosome - epigenome - genome - transcriptome – regulome measurement continuum. Additional key activities associated with establishing the number of entities in bio-measurement as a recognized quantity traceable to the SI, expanding the matrix measurement space for nucleic acid measurement, and including the consideration of identification and nominal properties were also expounded on. Mrs Parkes concluded by highlighting the need to collaborate across the newly established bioanalysis WGs and also to ensure that the needs of stakeholders are properly supported. Dr Brown commented that a counting unit was already an accepted part of the SI where CMCs were being accepted, for example for particles in air. Mrs Parkes agreed but stated that the community and the CMC process needed to recognize this and understand what it means for the bioanalysis area.

Following on from the question posed to the other newly created groups, Dr May asked what the group would consider to be a successful outcome after 5 years. Mrs Parkes replied that from an NMI perspective, nucleic acid measurement is quite mature, but the goal would be to see NMIs supporting nucleic acid traceability requirements, nucleic acid calibration services, certified reference materials and value assignment traceable to the SI for all relevant stakeholders.

9.4. Key Comparisons and CMC Quality Working Group (KCWG)

Dr Sin reported on the work of the KCWG. In 2015 a total of 568 CMCs were submitted of which 217 were from the re-review process. Dr Sin showed how the number of chemical and biological CMCs continues to increase and stood at 5757 as of March 2015. She noted how the use of the core competency approach is beginning to change the way that CMCs are generated and reviewed, as this is promoting a move towards broader scope claims. Dr Sin commented that the 'record cards' produced by the IAWG and OAWG are being well received by the KCWG and it is making the assessment of broader scope claims much easier. Dr Sin predicted that in some areas in the future, there would be hardly any one-to-one links between CMCs and key comparisons.

A number of observations were made by Dr Sin concerning the current cycle of CMC claims. In particular it was noted that if wider scope CMCs are to be submitted, these will need to be accompanied by additional supporting evidence (for example peer review reports). Dr Sin also mentioned that the KCWG had been unable to agree on how to deal with a number of claims that were method defined (for instance moisture in grain and milk powder). Dr Sin then proceeded to

highlight some opportunities to improve the effectiveness and efficiency of the CMC process namely: imposing hard deadlines and sticking to these, collecting more information on the intra- and inter-regional review process, and moving to a web-based review system. Dr Sin then outlined the service categories that were scheduled for re-review in 2016 (category 1 and 10) and 2017 (category 13). Dr Sin concluded by discussing an alternative approach to the review of CMCs which included an additional review step involving CCQM WGs that had been debated within the KCWG but which, as Dr Wielgosz later mentioned, was not being progressed further at the current time. Instead it had been decided to continue to encourage RMOs to meet the deadlines set.

Dr May opened the discussion and referred to the fact that one RMO had failed to meet the CMC submissions deadline in 2015 and as a result all of its CMCs had been moved onto the non-fast track. He questioned whether it was reasonable that this penalty should be applied to all of the NMIs within the RMO. Dr Botha replied that during meetings all RMO chairs had agreed to the timescales and to the penalties that would be imposed if deadlines were missed. Dr Wielgosz agreed that the KCWG had done a good job of trying to keep all RMOs to the agreed timescale and that keeping to agreed timetables was essential to the success of the whole process. Dr Sega expressed agreement with the hard deadline but was concerned that small NMIs should not be punished. Dr Kaarls stated that a move towards a web-based review system may simplify matters since there may not need to be separate review stages in such a case – all claims could be reviewed together by anyone. Dr Kaarls mentioned that this would be considered under the current review of the CIPM MRA. Dr Milton agreed that, from a JCRB perspective, the inter-regional review could be abolished, and that some metrology areas already do this. He further stated that the CCQM review process is much more deeply embedded than in other CCs and added in conclusion that the BIPM has been investigating web-based tools for a possible update of the KCDB. Dr Milton asked what the driver was for the fast growth in pure chemical CMCs – were these underpinning real services or to support the production of other CRMs. Dr Sin replied that this area was emerging as a core business for many customers, but Prof. Emons countered that this was more a result of the traceability statement within the CIPM MRA which he felt needed to be changed. Dr Wielgosz added that the KCWG should not be approving CMCs that support internal services. Dr May also credited the work of the BIPM work programme and the OAWG in driving an increase in activity in this area. Concluding the discussion on hard deadlines and penalties for CMC submissions Dr Sin agreed to change the wording of the penalty clause for late submission from “will be deferred to the next cycle” to “may be deferred to the next cycle” and to leave the final decision to the KCWG. This part of the discussion concluded with Dr Sassi requesting that a review of CMC service categories be undertaken since new categories were required, especially for the biology area. Mrs Parkes confirmed that WG chairs had already been asked to contribute to such a review.

Returning to the rejected CMCs on moisture content, Dr Brown remarked that these CMCs keep coming back every few years and keep getting rejected. Dr Brown asked whether those submitting the CMCs were being given any feedback and guidance. Dr May stated that once the measurand being addressed was properly defined the CCQM could consider them. Prof. Emons added that the method to make the measurement would also have to be defined. Dr May stated that it was not the CCQM’s job to define the measurement method in this case. Dr Kaarls stated that the International Organization of Legal Metrology (OIML) has been asked to set up a working group to establish and agree a globally accepted method for this measurement, but this had yet to produce a result.

9.5. *Ad hoc* Steering Group on Microbial Measurements (MBSG)

Dr Morrow presented (via weblink) the activities of the MBSG. She began by reiterating the role of the MBSG, namely: to establish contacts and cooperation with the stakeholder and participants; to invite representatives from the stakeholder community and NMIs/DIs actively developing microbial CRMs or having activities in the field of food measurements to join the MBSG; to work with stakeholders to define two relevant but simple measurement cases, of which the measurand can be clearly defined and for which a metrologically sound, validated method can be developed; to execute the two cases, including the organization of global comparisons, and reporting back to the CCQM and the microbial stakeholders; and to discuss and propose on the basis of the results what can be achieved, what should be planned and prioritized next, and how future cooperation can be best organized. Dr Morrow went on to note that the stakeholders identified by the NMIs were much broader than just the food industry and included the healthcare industry, environmental agencies, public and private bacteria collections, standards development organizations and regional governments and testing organizations. The measurement focus areas for the group are DNA sequencing (comparability in the confidence of base calls for microbial identification) and comparability of whole cell quantification.

Dr Morrow continued by informing participants that the recent study on microbial identity had been published in a peer-reviewed journal. The study compared results from multiple sequencing platforms for a multicopy gene as a first step in establishing comparability in microbial identity sequencing data. Dr Morrow stated that the methods developed are applicable to future multicopy gene sequence comparison studies, and provide additional levels of comparability between 16S rRNA gene sequences. She went on to explain that a report on establishing comparability of microbial cultural quantitation had been produced by the group and that this had prompted a proposed follow-on study using custom bioballs. Dr Morrow introduced the strategic planning exercise that had been carried out by the MBSG. This revealed that the current measurement services provided by NMIs and DIs included: whole cell reference materials in milk powder, meat and fish matrices; DNA reference materials; and supporting proficiency testing and inter-laboratory comparability. It was further stated that NMIs and DIs expressed an interest in CMC claims in the areas of DNA copy number ratios and colony counts for plate count techniques. There was expected to be more discussion of these topics in the MBSG meeting which would follow the CCQM plenary. Dr Morrow concluded by mentioning future studies planned by the group. These included work on microbial quantitation, microbial sequence analysis and anti-microbial resistance.

Dr May opened the discussion on the presentation by stating that there might turn out to be some overlap between the MBSG and the newly created working groups in the bioanalysis area, but that the MBSG would continue to operate as an *ad hoc* group for the time being and the extent of this overlap and any action that needed to be taken as a result would be assessed in due course. Dr May asked about the current constitution of the group. Dr Morrow stated that the group was mostly formed of NMIs, with a couple of other members (US Food and Drug Administration, and the ATCC) providing guidance rather than participating directly.

9.6. Working Group on Surface Analysis (SAWG)

Dr Unger reported on the work of the SAWG. In particular he noted that Brazil and the Russian Federation were new participants in the group. Initially the results of CCQM-K129 on $CuInGaSe_2$ (CIGS) alloy film composition were discussed. The spread of results presented was relatively small and this had been deemed a successful comparison. At this point Dr May interjected stating that any CMCs claimed from this study would be traceable to KRISS because they provided the primary reference (via an independent ICP-MS measurement) to all participants. Dr Unger replied that PTB provided its own traceability via their XRF facility. Dr Fajgelj stated that the uncertainty in the KCRV in this case is likely to be smaller than that which would have resulted if all of the participants had generated their own traceability. Dr Wielgosz added that in this respect all the measurements were highly correlated and it was not clear how much the uncertainty in the calibration standard contributed to the overall uncertainty budget. Prof. Emons expressed the opinion that as long as the result on the property value of the KRISS material was rigorously SI traceable then there was no problem. Dr Ellison remarked that the study provides information about the comparability of the laboratories with each other, but not about SI traceability. Dr Ellison further cautioned that a number of comparisons rely on a limited number of materials to provide traceability. Dr May reiterated that if participants claimed CMCs on the basis of this study they would need to continue to use the KRISS reference material or demonstrate that they had access to other appropriate reference materials to establish the traceability of their measurement results. Dr Wielgosz raised the additional issue that the unit 'at%' used to express the measurement result were not part of the SI and would need to be changed. Dr Kim asked how far the light shone for this study. Dr Unger replied that this would need further discussion at the working group.

The discussion moved onto CCQM-P130 on Electron Probe Micro Analysis of AuCu alloys where the measurand was previously k-ratio but, following a question from Dr Milton, Dr Unger confirmed that the quantity to be measured was amount of substance. Dr May stated that this case was the same as CCQM-K129 in that the traceability came solely from NIST SRMs. Dr Fajgelj added that if all participants use the same standard then the overall uncertainty of the comparison is reduced and it has less value as a result. Dr Brown further remarked that this meant there was not enough redundancy in the measurement system to fully encompass the uncertainty of realization of the measured quantity with respect to the SI. Dr Sargent informed attendees that in some IAWG studies participants provide two measurement results, one using their own standards and one with a common standard provided for the comparison. Dr Sargent observed that this helped participants separate out the uncertainties and biases in their measurement methods. Dr Mariassy added that in the case of CCQM-P130 it was very important to be clear what the comparison was for: comparability of measurements, or to assess the quality of service to customers (with or without using one's own reference material). Dr Wielgosz asked Dr Unger whether, as per the report of last year's meeting, that conversion of the k-ratio data to mass concentrations via calculation had now been excluded from the comparison. Dr Unger confirmed this was the case; he also stated that WDX uncertainties from NIST were required in order to complete the study.

Dr Unger moved on to introduce a proposed key comparison of specific surface area, specific pore volume and pore diameter. Prof. Emons enquired as to whether everyone used the same method. Dr May added that there was no point in specifying a standard method unless it is the same one that is used to deliver services to customers. Dr van der Veen commented that the method suggested did not give an absolute value but instead provided a method defined measurement called BET area based on the use of nitrogen adsorption. Dr Milton requested that the relationship between the NMI in The

Islamic Republic of Iran and the proposed guest laboratory RIPI, from the same country, be determined and reported back to the CCQM. Dr Wielgosz reminded Dr Unger of the procedure for guest laboratories to participate in pilot studies and asked what the proposed guest laboratories offered and whether the study could proceed without them. More generally, Dr Wielgosz requested a review of existing CMCs for surface area determination, especially with regard to the traceability statements. Dr Sargent asked whether the BET methods used a standardized protocol. Dr Unger stated that the method was defined in general terms by an ISO standard but there are still slight differences in implementation. Dr Brown enquired as to why this was not a traceability exception. Dr May reminded attendees that comparison exercises must reflect the real measurements offered to customers and should not simply be proficiency testing schemes carried out under unrealistically ideal conditions.

Following a brief introduction of progress with a repeat of CCQM-K32, Dr Unger introduced proposed future SAWG studies. These included a study of Raman surface analysis at ambient conditions, amount of matter in buried organic layers, and shell identity and amount of matter in a shell on an engineered nanoparticle. This provoked a number of questions about the details of these studies. Prof. Emons asked how focal volume in the Raman study would be calculated and Dr Wielgosz asked what the measurand was. Dr Unger replied that materials and methods for focal volume measurement were available from PTB and NIST and that the measurand was amount concentration. Regarding the comparison on amount of matter in buried organic layers there was general agreement from a number of attendees that amount of matter was not an acceptable term and that the chemical measurand needed to be specified. Following a question from Dr Milton, Dr Unger confirmed that the thickness of the layers was expected to be 10 nm. Dr Wielgosz remarked that there would most likely be a lot of guest laboratories interested in participating. Dr Unger confirmed that this was probably true and that they would need to be selected carefully.

9.7. Working Group on Bioanalysis (BAWG)

Mrs Parkes presented the activities of the BAWG. Considering that there had only been one meeting of the WG since the last CCQM with few results presented, and furthermore that the BAWG was to be split into the three new WGs, Mrs Parkes took the opportunity to reflect on the achievements of the group since its inception. In particular Mrs Parkes highlighted CCQM-P154 on absolute DNA quantification which provided a route to nucleic acid measurement traceability, and whether this would enable NMIs to claim a core competency in this area based on digital PCR approaches. The achievements of CCQM-P103.1 on gene expression biomarker profiling in achieving good measurement agreement and consensus on a way forward for CMC claims was described.

Mrs Parkes then discussed the protein measurement space and the activities, gaps, comparison requirements and future direction in this area. The studies that have underpinned RM production in the bioanalysis area were then reviewed, in particular with respect to requirements for identity confirmation, purity assessment and quantification through amino acid analysis, production of pure protein calibrants, immunoassay method for proteins and enzyme activity. The workshop on protein purity taking place after the CCQM meeting was mentioned by Mrs Parkes who elaborated that there would be sessions on: current practice of NMIs in purity assessment, RM producer perspective – current approach and requirements, and the state of the art in protein characterization measurement.

The discussion of the BAWG studies on cells (CCQM-P102 and CCQM-P123) led onto Mrs Parkes describing the current issues faced by the bio-measurement area. The first issue mentioned related to

counting, for instance in relation to cells, and the work required to enable bioanalysis CMCs using counting as their traceability route to be accepted within the KCDB. This led onto a wider discussion of the bioanalysis CMCs that had currently been accepted into the KCDB and the CMC review process that was in place for BAWG claims which, unusually for the CCQM, undergo WG review as part of the process. Mrs Parkes concluded by reviewing the progress made with regard to the BAWG roadmaps and the following key outcomes generated by the work of the group: substantial developments in NMI inter-laboratory precision for many NMIs in nucleic acid quantitation, uncertainty budgets (including published guidance) for nucleic acid quantitation by qPCR; a strategy for SI traceability for peptide measurements; reduced uncertainty in key cell measurements; and significant NMI research collaboration. Mrs Parkes acknowledged the key role of BAWG participants in achieving these outcomes and in particular thanked Dr Knight (NPL) for his work as rapporteur.

Dr Emons commented that few users are interested in a single defined molecular protein and that in the protein area the amount of substance concentration of all proteins with a specified functionality is instead relevant. Mrs Parkes agreed but was of the opinion that the studies on single proteins were the best way to start addressing the problem.

9.8. Working Group on Electrochemical Analysis (EAWG)

Dr Mariassy gave an update on the work of the EAWG. Since its inception the group had performed 25 key comparisons and 15 pilot studies resulting in 78 CMCs in pH and 37 in electrolytic conductivity. The results from CCQM-K99 on physiological phosphate buffer solution were introduced. Dr Mariassy noted that the comparability was generally very good but that more deviation was observed at more extreme temperatures. At this stage Dr May asked how the comparability had improved since the similar CCQM-K9 study 15 years ago. Dr Mariassy replied that it had showed improvement for the NMIs that had taken part in both studies, but that this was masked by new NMIs that had established capabilities in more recent years. Dr Wielgosz stated that if the comparison continually demonstrated agreement amongst participants with limited changes in reported uncertainties, the time period between comparisons could be increased. Dr Brewer was of the opinion that this was arguably the most specialized, technically and experimentally demanding work in the CCQM and furthermore an area where participants relied on bespoke equipment that they made themselves, and so the aim was more to do with maintenance of traceability for a very challenging quantity rather than to seek large improvements over time. Dr Sargent mentioned that new comparisons would be needed to support new NMIs who wanted to claim CMCs.

Dr Mariassy introduced CCQM-K48.2014 – a KCl assay based on chloride amount content determination. The results, especially for the experienced laboratories, were very good and showed improvement over, or stability compared with, CCQM-K48. Following the presentation of the results of SIM-QM.K91, Dr Mariassy introduced the preparative conductivity study CCQM-P143. This was a comparison of CRMs for electrolytic conductivity which was designed to underpin CMC claims for CRMs. Dr Mariassy noted that the comparison had worked extremely well but remarked that if there had been too many more laboratories then there would have been too much work for the coordinating laboratory to manage. Dr May stated that he saw this as an excellent example of a comparison that tested the services provided by the laboratories themselves. Discussion of CCQM-P152 on phthalate buffer in water/ethanol then took place. It appeared that there had been some stability issues caused by the esterification of phthalate by the water/ethanol solution. Dr Mariassy reported that the EAWG

had decided to make a correction for this effect in the evaluation of the results. Following on from this study, CCQM-P153 on the electrolytic conductivity of bioethanol was presented. A fairly wide spread in results was noted, and it seemed that there may have been a homogeneity issue with the samples, rather than an issue with stability. Dr May asked whether a similar study of normal ethanol against bio-ethanol had been performed to determine whether or not this was just a matrix problem. Dr Jakobsen said that had not been done yet and would be a good idea for future work. Further she remarked that previous comparisons on bioethanol had shown similar problems.

Dr Mariassy mentioned the technical presentations given to the EAWG. In particular there was very interesting data on how the deviation from the reference values of NIST pH SRMs had correlated with changes in staff. Where training of successors had been adequate prior to handover, the quality of SRMs had continued to improve. When there had been insufficient training before handover, or breaks in the pH SRM programme, there was a clear degradation in the quality of the SRMs. Dr Mariassy remarked that this showed how important the scientists themselves are in the maintenance of measurement quality. Dr May remarked that he felt this should remind us that capability resides with the staff themselves and not the NMIs *per se*. Dr Mariassy concluded by summarizing the EAWG's plan of comparisons up until 2019, and mentioned some of the current issues facing the group. One of the major ones was finding coordinators with the necessary equipment, skill and capacity to conduct comparisons. Dr Mariassy also mentioned the challenges posed to the group by the proposed changes to the Guide to the Expression of Uncertainty in Measurement. Dr Brown asked what these challenges were and Dr Mariassy replied that the proposed requirement to calculate probability density functions was felt to introduce too much difficulty for users.

9.9. Working Group on Organic Analysis (OAWG)

Dr Mackay reported on the work of the OAWG. She began by reminding attendees of the OAWG's four-track approach to comparison studies: Track A: key comparisons that test core competencies for the delivery of measurement services to customers (providing primary calibration reference services and accuracy control reference services), Track B: key comparisons that assess the equivalence of measurement services actually provided to customers (associated with certified reference samples and value assigned PT samples), Track C: key comparison studies in emerging areas of global interest and importance, and Track D: capability assessment studies. Dr Mackay then outlined the Track A purity comparisons carried out by the group in recent years and showed how these mapped onto the molar mass and polarity space. As a result of the comparison programme on the purity of organic calibrators undertaken in the group it was noted that the first broad scope CMC claim for organic purity (from NRC) had just been accepted in the area of qNMR. Dr Mackay noted that in this case the traceability was stated as being to NIST since that was the source of the pure organic internal standard used. The Track C comparison on avermectin purity was discussed next and in particular the challenges caused by the presence of a diastereomeric impurity and water uptake by the sample once the bottle was opened. This led onto a presentation of the preparation for CCQM-K55.d on folic acid purity where sorption studies had highlighted the effect of relative humidity at constant temperature on the water content of the material – these changes had been observed to have a measurable but reversible effect.

Dr Mackay reported on the CCQM-P150 qNMR pilot study. There had been a detailed investigation of the influence of data acquisition parameters. There was a clear correlation between peak shape and accuracy and this indicated that shimming was one of the most important considerations for accurate

quantification. The study had highlighted aspects of sample preparation, data acquisition and data processing which appeared to be of most importance.

Dr Mackay then concluded by reviewing the planned future OAWG studies, noting in particular the desire to make the 'how far the light shine' statements as wide as possible in the Track A series and she presented an example of the approach being used for this by the OAWG. This defines a measurement space with respect to molecular weight range, polarity range, mass fraction range and matrix type.

The Track A KC occurring in 2015 covers measurements in the clinical area with the model system being urea and uric acid in human serum. In conjunction with this, a Track C KC for the important area of Vitamin D in serum will occur which requires very low mass fraction measurements to be carried out. It was stated that the 2016 future Track A comparisons in the food area would try to cover high-polarity analytes in food, noting that there was a strong bias to the 'contaminant' service category over the 'nutrient' service category in this area for current CMCs. The timetable of future comparisons for the OAWG currently included about 10 key comparisons in the next three years.

Dr Ellison asked whether there were other influence factors in CCQM-P150 aside from shimming. Dr Mackay stated that there were a large range of factors that had been thoroughly investigated and presented by NMIJ (and the original presentation from NMIJ contained many more slides) but that shimming was considered to be one of the most significant factors. Dr Plant enquired as to whether any of the analytes being considered in comparisons were unstable. Dr Mackay stated that some analytes, for example some pharmaceuticals in water, where unstable and in these cases there were currently no CMCs in this area. A KC for stable pharmaceuticals in water which has just been completed was reported by Dr Mackay as part of her report. Dr May added that a stability study is always conducted first, prior to any comparison, to ensure the sample is appropriate for a comparison over a given time scale and so as not to waste the time and money of participants.

9.10. Working Group on Inorganic Analysis (IAWG)

Dr Sargent presented the work of the IAWG and referred in particular to the improved and updated IAWG core capability tables that are accessible on the BIPM website. Dr Sargent commented that the spread of sulphur results in CCQM-K123/P157 was quite large and whilst this was not unexpected the uncertainties quoted were not consistent with this spread. The coordinators, NMIJ, were going to re-examine the uncertainties attributed to the samples and quoted by the participants. Dr Sargent then reported on CCQM-P149 on the purity of zinc. He stated that the aim of this study was for assessment of calibration solutions produced for in-house use and that this would go some way in helping provide confidence in this difficult area that had originally been highlighted by the CCQM as a possible traceability exception in early discussions on the topic.

Dr Sargent presented a number of future comparisons planned by the IAWG and summarized these on a Gantt chart of the progress of key and pilot comparisons within the group. In particular, Dr Sargent highlighted CCQM-K108/P171.2014 on the determination of arsenic species and total arsenic in brown rice flour. The previous study CCQM-P171 had caused problems for the measurement of the arsenic species, so on this occasion Dr Sargent had suggested that the speciation measurements were made only as part of the pilot study.

At this stage, prompted by Dr May, Dr Sargent explained more about the isotope ratio delta scale in inorganic chemistry. Dr Sargent highlighted that the use of the delta scale has the advantage that the

uncertainties of isotope ratio measurements are lower but the disadvantage that the values produced are not fully SI traceable. In this respect the delta scale is a conventional scale and Dr Sargent stated that a number of NMIs within the IAWG have research programmes aimed at improving the accuracy of isotope ratio measurements to put these on a SI traceable scale. Dr Wielgosz noted that the CIPM had adopted the traceability exception related to delta value isotope ratio measurements proposed by the CCQM via Decision CIPM/104-26. Dr Wielgosz also noted the encouragement from the CIPM for the continuation of programmes within the NMIs to develop absolute isotope ratio measurement values, although he noted that in many cases measurement uncertainties would need to improve by an order of magnitude to be better that the delta scale and so major challenges remained. It was Dr Wielgosz's opinion therefore that in the meantime it was important to continue to work with organizations such as the IAEA to ensure better dissemination of the delta scale, which was widely used by those undertaking isotope ratio measurements. Dr Fajgelj stated that running out of delta scale reference materials was a serious problem and this should be an area that the BIPM should consider supporting in the future.

Dr Sargent went on to describe the CRM and CMC survey conducted by the IAWG. This had showed that the number of new CRMs outnumbered CMCs and he remarked that this pointed to the conclusion that comparisons supported real services that were being delivered. Dr May expressed his concerns that whilst capabilities may be being maintained this did not necessarily mean that real services were being provided. Dr Sargent countered that most services were delivered in this area in the form of CRMs and not by reference measurements.

Dr Sargent described the IAWG workshop on the purity assessment of metals standards that had taken place during the IAWG. The output of this workshop would be a roadmap designed to underpin the fit-for-purposeness of in-house calibration solutions and make SI traceability more transparent in this area. However, Dr Sargent added that a lot of traceability in this area comes from solutions produced from pure salts rather than metals. He added that this would be an area that would be targeted in future, in collaboration with EAWG, where a lot of the assaying work is done.

Returning to the initial discussion about the spread of results in CCQM-K123/P157 Prof. Emons commented that the same problems have been observed for other materials of plant origin, so this may not just be related to biodiesel. Prof. Emons went on to note that in most cases sulphur is at such low concentrations in the real materials that there is no real driver for these measurements except the academic challenge. Dr Haraldsson replied that industry laboratories have expressed the need for a measurement infrastructure at lower concentrations, especially for elements such as sodium.

Dr Sargent concluded by presenting a plan for future comparisons up to 2019. In response to this Dr Milton asked how the priority areas identified mapped onto core capabilities. Dr Sargent replied that the comparisons fitted neatly into the proposed multi-track approach, especially for Tracks A and B, less so for Tracks C and D but he expected these to be more aligned moving forward. Dr Milton suggested that using the same unified nomenclature would be helpful. Dr Sargent agreed and stated that he saw this as being addressed during the revision of the overall strategy.

Finally, Dr May and Dr Sargent took the opportunity celebrate the substantial contributions to the IAWG and to the CCQM of Dr Turk, who had recently died. In particular the leading contributions of Dr Turk to the conception and implementation of the core competencies approach in IAWG were gratefully acknowledged.

9.11. Working Group on Gas Analysis (GAWG)

The report of the activities of the Gas Analysis Working Group was delivered by Dr Kim. It was noted that the current workload of the group and falling numbers for GAWG meetings away from Paris has led the group to decide to skip a meeting in the second half of 2015, however they did expect to hold two meetings in 2016, as the reporting of the results of a number of key comparisons was expected in 2016. Dr Kim noted that the group had 12 comparisons ongoing or due to start in 2015 and four new comparisons planned for 2016 and 2017. A number of comparisons showing good agreement across participants were reported: CCQM-K82 on ambient level CH_4 where comparability was approaching WMO data quality objective levels, CCQM-K84 on ambient level CO where the comparability whilst good was still three times the WMO data quality objective because of instability owing to oxygen in the cylinders, CCQM-K94 on 10 µmol/mol dimethyl sulphide in nitrogen, and CCQM-K101 on 10 µmol/mol oxygen in nitrogen which proved more challenging than expected owing to the presence of argon in the mixture. This final comparison will be used to claim CMCs for oxygen in nitrogen in the presence of interfering components. Dr Kim proceeded to update attendees about other comparisons in progress, in particular CCQM-P111 where the comparison was now being followed up by supplementary comparisons at the RMO level, and CCQM-K113 on noble gas mixtures where results had been distributed to participants but there were some significant discrepancies which needed further discussions.

Of the comparisons planned for 2015, Dr Kim highlighted CCQM-K117, which was the follow-up to CCQM-K46 on NH_3 in nitrogen conducted in 2005. The earlier comparison had demonstrated biases associated either with stability or measurement method, however recent work was thought to have eliminated these problems and so now was considered to be a good time to re-run the comparison. The outline programme of work presented by Dr Kim proposed an average of four comparisons a year up until the end of 2019 and included a follow on from CCQM-K52 on ambient level carbon dioxide (with a separate key comparison of isotopic composition of pure CO_2), and repeats of CCQM-P73 on NO in nitrogen, and CCQM-K41 on hydrogen sulphide. Dr Kim also mentioned the measurements performed by the BIPM on the ozone absorption cross section at 254 nm, which is the basis of the UV method for surface ozone standards. He reported that the GAWG had decided to establish a task group to review published ozone cross sections values, and recommend a value and uncertainty for use in future rounds of BIPM.QM-K1. Dr Brown asked whether legislators were being involved in the process since it is the limit values specified for ozone in their legislation that would be most affected. Dr Wielgosz replied that this was part of a much longer process and the first thing to do was to consult with scientists on the best value to use, and after this, consultation with legislators would follow.

Dr Kim described the GAWG strategy for comparisons and core competencies. The nomenclature and classification followed the Track A, B, C and D system used by the OAWG. Dr Kim also introduced the system proposed by the GAWG for generating wider scope CMC claims, in particular across larger concentration ranges and across core components, and for gas purity claims. Finally, Dr Kim summarized the outcomes of the GAWG Particulate Workshop which took place prior to the main GAWG meeting. The objective of the meeting was to discuss the process of putting in place metrological traceability for aerosol measurements. In particular, this included measurements such as aerosol optical and chemical properties, particle number and mass concentration, and black carbon and other chemical components. Dr Kim noted that these measurements underpin the requirements of legislation in the air quality, stationary source emissions and vehicle emissions areas. The workshop had identified a number of priorities and activities, namely: to generate a roadmap towards

comparable black carbon/elemental carbon measurements, to establish traceability for aerosol particle number measurements in the size range > 500 nm, to organize inter-comparisons of particle number measurements on a global scale, to consider a comparison of cut-offs of PM_{10} and $PM_{2.5}$ samplers. Dr Wielgosz added that these activities would be taken forward by two task groups: one to produce the roadmap towards comparable black carbon/elemental carbon measurements and another to develop a strategy for particle comparisons within the GAWG.

Returning to the discussion of core competencies, Dr May expressed concern that the flexible scope approach would lead people to make claims for capabilities outside those which they actually deliver. Further, he expressed the opinion that the strategy must be a tool to judge claims, not determine what the claims should be. Dr Kim agreed, although commented that was a circular argument since in many countries one cannot deliver services until one holds CMCs. Dr Milton added that he thought it provided a way of assessing 'how far the light shone' for a given comparison.

10. TRACEABILITY IN THE CIPM MRA (AND CCQM LIST OF EXCEPTIONS)

This agenda item was covered as part of the report on the IAWG. Decision CIPM/104-26 of the CIPM had adopted the traceability exception related to delta value isotope ratio measurements proposed by the CCQM. Dr Wielgosz also noted the encouragement from the CIPM for the continuation of programmes within the NMIs to develop absolute isotope ratio measurement values.

11. BIPM PROGRAMME ON METROLOGY IN CHEMISTRY

Dr Wielgosz presented the BIPM Programme on Metrology in Chemistry, noting that the activities agreed for 2016-2019 were based on the dotation agreed by the CGPM in November 2014. Dr May added that the BIPM Chemistry Programme had still grown in its level of activity because of in-kind contributions from the CCQM community, for which Dr May and Dr Wielgosz proffered grateful thanks. Dr Wielgosz then introduced the major work areas for the BIPM for 2013-2015, namely: international equivalence of gas standards for air quality and climate change monitoring, and comparisons of primary references for organic analysis. Dr Wielgosz listed the comparisons that the BIPM had coordinated, or were in the process of coordinating over this period. Dr Wielgosz demonstrated the improvements in comparability that had been achieved by CCQM-K82 on methane in air standards compared to a similar comparison ten years ago. He also described the series of comparisons involving qNMR for which a target standard uncertainty of 1 mg/g was considered achievable, and the standard deviation of results in comparisons was improving, suggesting that this may be reached in the next few years. In published BIPM coordinated key comparisons in 2013 and 2014 there had been 72 NMI participations. It was noted that for comparisons in 2014 and 2015, in the planning and measurement phase, an increase to 96 NMI participations was expected. Dr Wielgosz highlighted CCQM-K115 on C-peptide purity as an important step in covering the measurement space for peptide primary structure purity determination. Further the importance of CCQM-K120 on carbon dioxide in air was mentioned. This comparison would require isotope ratio

measurements for corrections to carbon dioxide concentration measurements required at the ± 1‰ level. The BIPM had already made substantial progress in this area by comparing a number of different carbon dioxide blends from the NIST and NPL that had been prepared using different carbon dioxide sources. Dr Wielgosz highlighted the BIPM manometric facility which was being established and mentioned that the BIPM were looking for secondees from NMIs with experience in pressure measurement to help with the experimental work.

Dr Wielgosz presented the ozone cross section work performed by the BIPM and informed attendees that further measurements were under way on a redesigned gas phase titration facility at the BIPM. He stated that a GAWG task group would start discussions about the best value to use for the ozone cross section. After presenting the involvement of the department in developing documentary standards on eight committees and the eight peer-review publications by the department over the last two years, Dr Wielgosz moved on to thank the ten secondees from NMIs that had supported the BIPM and CCQM comparison programme in 2013-2015. He then described the six BIPM secondment opportunities for NMI visiting scientists in 2016.

Dr Wielgosz mentioned the donation of a new NMR instrument to the BIPM following establishment of cooperation with the NMIJ in the qNMR area, in particular for the CCQM-K55 series of comparisons, and developing qNMR methodology to demonstrate compatibility of measurements at the 1 part in 10^3 level. The donation from KRISS for the purchase of a GC-ECD instrument at the BIPM was also gratefully acknowledged. Dr Wielgosz expounded on the strategic plan for the department's activities up to 2019. BIPM laboratory coordination of comparisons are requested when a) the comparisons are fundamental to a broad range of NMI services and require a long-term commitment to their coordination; or b) comparability at the smallest levels of uncertainty needs to be demonstrated for high impact measurands on a continued basis. A number of planned comparison exercises were highlighted up to 2019. In particular it was noted by Dr Wielgosz that the comparison on carbon isotope ratio measurement in 2019 was approved by the CGPM but not funded, however joint working with the IAEA will allow this comparison to go ahead. Dr Fajgelj commented that this comparison would be very useful for the community.

Dr Wielgosz concluded by mentioning upcoming workshops organized by the BIPM Chemistry Department, in particular the workshop on Global to Urban Scale Carbon Measurements at the end of June 2015. Finally Dr Wielgosz demonstrated to attendees the aluminium 'Avogadro Cube', which along with the NIST 'Lego® Watt Balance' was designed to engage participants at the 'Chemistry and the International System of Weights and Measures' Symposium at the American Chemical Society (ACS) National Meeting in August 2015 with the redefinitions of the mole and kilogram. Dr May thanked Dr Wielgosz for the presentation and stated that the BIPM Chemistry Programme continued to work well to support the CCQM and its WGs.

12. PROGESS WITH THE PROPOSED FUTURE STRUCTURE OF THE CCQM

This agenda item was covered by the discussions in agenda item 2.

13. REPORT FROM THE AD HOC WG LOOKING AT HOW THE PROCESS OF CMC GENERATION AND REVIEW COULD BE IMPROVED IN A CCQM CONTEXT

Dr Kaarls presented the progress on the CCQM review of the CIPM MRA and the KCDB. Dr Kaarls began by reminding attendees of the background to the CIPM MRA and the needs that led to its creation. Dr Kaarls noted that the outcome – a database of normally and regularly delivered calibration services underpinned with the results of Key Comparisons – used a database template that was in common use at the time in the physical measurement community and in the accreditation arena. Furthermore, at that time, it was decided that for the chemical area the database was not intended to contain just a list of available CRMs. A list of all available CRMs should be found in the catalogues of the NMIs/DIs concerned. Dr Kaarls reflected on the status of the CIPM MRA in 2015. In March 2015 there were more than 24,000 CMCs in the database, of which about 5800 related to chemical and biological measurement. This had led to a position where the workload and costs of the processes involved in maintaining the CIPM MRA in its current form were too high. Dr Kaarls stated that there was a need to consider efficiency and efficacy and to answer a number of pertinent questions; for example: Are all comparisons strategically well chosen? Can we make do with fewer? Is the intra- and inter-RMO review system sufficiently efficient and effective? Is the quality management system sufficiently effective? Is the database fulfilling needs and expectations? Which potential user communities should the database be designed for? Are all claimed CMCs really regularly delivered services? Should all real services be published, such as a list of all available CRMs? Is there a need for a different type of database?

Dr Kaarls reported that these questions had prompted NMI Directors, together with the CIPM, to perform a general review of the CIPM MRA in 2015. Input had been requested from all CCs and as part of this the CCQM established an *ad hoc* WG on CIPM MRA review in 2013 and performed an electronic survey amongst CCQM members in 2014. The CCQM report on its findings was due to be delivered to the CIPM in mid-2015. Dr Kaarls commented that the CCQM survey had received responses from 33 NMIs. The main conclusions had been that the CIPM MRA was without doubt useful and the KCDB with the CMCs it included was an essential part of this. However there were areas that the NMIs thought could be improved: the database should be more understandable and easier to use and should recognize the different types of services that NMIs deliver to customers. There was also general support for CMCs covering a wider scope, and a conclusion that some areas, such as biology, may need a different template for their CMCs. There was support for widening of the core competencies approach and a reduction in the number of key comparisons. Furthermore a much more efficient and effective harmonized intra- and inter-RMO review process of CMCs, possibly using a web-based system, was generally thought to be a requirement of any revised system. Dr Kaarls then listed the ten recommendations proposed by the CCQM *ad hoc* WG on CIPM MRA review based on the responses to the survey:

1. Determine again who the different users of the KCDB are, and what type of information they really need.
2. Depending on the different user groups and the type of services delivered, there may be a need for different CMC templates, such as:
    - CRMs (e.g. compare with the JCTLM database)
    - Assigned reference values for PT schemes
    - Assigned reference values for in-house working standards from customers

- Measurement standards for identity classifications, also in microbiology.

3. Replace the current KCDB by a KCDB with fewer CMCs with a wider scope.
4. Underpin CMCs with a wider scope with:
    - Key Comparisons that have tested the core capabilities and competences
    - A record card demonstrating the long-term performance of the NMI/DI
    - More detailed on-site peer review reports or accreditation certificates.
5. Adapt the current CCQM Service categories in order to accommodate the CMCs with a wider scope.
6. Explore the possibility of introducing a systematic and complete on-site peer review/assessment, either by an independent CCQM peer review team or a peer review team operating under the aegis of an ILAC recognized accreditation body.
7. Reconsider the intra- and inter-RMO CMC review process, in particular the roles of, and activities in this of the CCQM KCWG, CCQM WGs and the RMO TCs on Metrology in Chemistry (TCQMs).
8. Move to a web-based, combined, intra- and inter-RMO review system; the role of the KCWG becoming reduced to an overall coordinating and harmonization activity.
9. Continue the strategic long-term planning of Key Comparisons and Pilot Study comparisons as has currently been implemented and published by all CCQM WGs.
10. Consider the need to distinguish between the assessment of a well developed NMI/DI and the assessment of a developing NMI/DI by underpinning the more simple CMCs with larger uncertainties and no wide scope of the newcomers by:
    - The results of simple (bilateral) comparisons
    - The review of validation reports
    - The review of on-site peer review reports containing sufficient details of the NMI/DI's laboratory, its equipment, procedures and staff
    - Its commitment of active participation in the RMO TCQM and eventually the CCQM.

Dr Kaarls concluded by presenting the next steps in the process. He stated that following discussion by the CCQM, these proposals would be revised and finalized by the CCQM *ad hoc* WG on CIPM MRA review (which would meet directly after the CCQM). These would then be presented to the CIPM as the CCQM input to the general CIPM MRA review in October 2015. It was likely that in the absence of any further tasks, the CCQM *ad hoc* WG on CIPM MRA review would then be disbanded.

Dr May began the discussion by remarking that the on-line survey of KCDB users had shown that NMIs were the main users and he asked therefore how the system could be modified to encourage more and different people to use it. Dr May continued to elaborate that it was not so important who was using the database now, but more so who should be using it in the future as this should drive the proposals of the CCQM. He asked Dr Wielgosz to present a slide summarizing possible ways forward for the future structure of chemical and biological CMCs in the KCDB, based on some of the responses received to the CCQM questionnaire, as three broad options:

1) No change
2) Introduce the concept of 'broad claim' CMCs in the current system
3) Move to a 'JCTLM structure' of data listing available CRMs and available reference measurement services of NMIs.

Dr Wielgosz elaborated that all three choices had advantages and disadvantages with the amount of change and of work required to implement the changes increasing in the order 1, 2, 3. These proposals prompted a lengthy and involved discussion.

Dr Watters stated that needing to know the identity of the customer for the services is a key requirement. For instance, he continued, if it is mostly NMIs that visit the database, and then only because they want to check the maintenance of the information relevant to their institution, but customers go straight to the NMIs for the information, then the database has little value. Dr Wielgosz replied that 75 % of chemical and biological CMCs come from only eight countries (China, Germany, Japan, Republic of Korea, Mexico, Russian Federation, United States of America and the United Kingdom) and perhaps these countries could be the first to answer this question. Dr Kaarls summarized the four questions he felt that the CCQM should be answering with respect to the KCDB: who should the customer be, should wider scope claims be accepted, is a different template required, and should there be a differentiation between established NMIs and newcomers? Prof. Emons expressed concern that the CCQM itself might not be the best forum to provide these answers, especially concerning whether CMC claims should have broader scope. Referring back to the original presentation by Dr Kaarls, Dr Fajgelj asked how many of the NMIs holding chemical and biological CMCs have formal accreditation (considered as an alternative to assessment via peer review). Dr Kaarls replied that he did not know the exact figure but expected this to be in the range of 50 % to 60 % holding accreditation. Dr Fajgelj thought that this was quite encouraging and was certainly an improvement on previous years. He went on to comment, on a different subject, that he thought the lack of understanding of the KCRV was a source of problems and confusion in the present process and perhaps a 'target acceptance range' would be more helpful. Dr Kaarls responded that this was an interesting idea but that the KCRV did have a clear meaning in most comparisons. Dr May agreed, stating that the KCRV was the best estimate of truth where there was no independent reference value. Dr May also stated that on some occasions he felt there was a need for smaller and less experienced NMIs to have CMCs in the database where there were no tangible services. In this respect Dr May wondered whether two databases, one to catalogue capabilities for services and one to record the results of comparisons, would be a useful initiative.

At this stage in the discussion, Dr May returned to the idea put forward by Dr Wielgosz to ask the eight largest producers of chemical and biological CMCs what their current and future requirements for the KCDB were. Ms Li (on behalf of NIM, China) thought that the database was mainly for customers and it enables customers to choose the best CRM or service to use. Prof. Panne (on behalf of BAM, Germany) reminded attendees that the COMAR database already listed CRMs, to which Dr May replied that not all the CRMs on that database were quality assured. Prof. Panne added that BAM provided many services as a DI that are not on the KCDB; furthermore, the main use of the KCDB within BAM was for internal use to support their accreditation and that customers came straight to BAM for information on services. Prof. Panne concluded by stating that he saw no reason for major changes now. Dr Güttler (on behalf of PTB, Germany) stated that he considered the KCDB as a record of services that PTB can offer, and that the difference between the KCDB and the internal PTB list is that the KCDB brings additional international quality assurance which provides extra confidence. Dr Güttler further remarked that the KCDB will be required into the future, and that if we

did not have it, it would need a replacement, which could itself have just as many problems. He stated he was in favour of no change, although he went on to concede that the requirements of chemistry and biology are complex and therefore a pragmatic approach is needed. Prof. Panne added that as broad claims were already being accepted he thought that the CCQM was already on the way to adopting option 2 on Dr Wielgosz's summary slide and perhaps this, not option 1, represented the *status quo*. Dr Fujimoto (on behalf of the NMIJ, Japan) expressed support for the introduction of a broad claim system and stated that he felt CMCs were quite difficult for the user to understand. He therefore felt that a mix of options 2 and 3 from Dr Wielgosz's slide represented the best way forward. Dr Kim (on behalf of the Republic of Korea) mentioned that many CMC claims already contained CRM numbers and reminded attendees that these claims were already reviewed on a five-year basis. Although recognizing that the KCDB was currently accepted by customers, he felt that a move to use the database in the mode of option 3 would better identify the service provided to external customers. Dr Pérez-Castorena (on behalf of CENAM, Mexico) thought that some changes were needed to help customers better understand the services that were offered – option 3 for customers to use, together with option 1 for internal CCQM use. Dr Kustikov (on behalf of VNIIM, Russian Federation) stated that his customers always asked whether the services he was providing were traceable to the information on the KCDB, and that it was a very useful record to provide conformation of this. He went on to express the opinion that it would be useful to have links to the database from internal documents. Dr Kustikov mentioned that the database did require modernization, not least from the reasons he had just mentioned, but that this should be by evolution not revolution. In this respect he felt that the database must be useful for customers but that it must continue to focus on the capability of laboratories in comparisons. Dr Brewer (on behalf of the NPL, UK) expressed the opinion that option 2 seemed a good way forward but that this had also to be linked to a simplification of the review process to reduce work. Dr Adeogun added that the NPL's accreditation scope in the reference gas mixture area linked directly to the KCDB. Dr Locascio (on behalf of the NIST, USA) supported changes to the database. She stated that the database was not currently used by government or stakeholders and must change to be useful for stakeholders; in this respect Dr Locascio thought option 3 presented the best way forward.

Following this input from the eight countries producing the most chemical and biological CMCs there was a wider debate among other attendees. Dr Magnusson supported the need for change, to support broader scope CMCs and to consider the customers' point of view. Dr Vaslin-Reimann also supported modernization of the database to make it clear and understandable for customers and agreed that the outputs must be customer orientated. She also suggested that a better, more flexible search engine for customers would be a great improvement. Dr Emons asserted that options 1, 2 and 3 were difficult to consider as they would need to be delivered differently for different areas, for instance the JCTLM database has been created in a specific format for a specific use. He went on to state that there may be different requirements for different technical areas, and even for different regions. Prof. Emons mentioned that he thought that most customers contacted the Institute for reference Materials and Measurements (IRMM) directly for services rather than first coming via the KCDB. He reminded attendees to consider the competing needs of accreditation when deciding on how to revise the database, in particular what other information would be useful to include. Dr Botha asserted that NMIs all have very specific relationships with their customers and it would be very difficult to recognize this in one database. In addition Dr Botha voiced the opinion that Appendix B gives most of the information required about comparisons and perhaps this could be updated to include a summary record of the overall participation of NMIs/DIs. Dr Jakobsen noted that it was important that the information was useful for customers and accreditation bodies, but that this was not necessarily the same thing. She stated that in Denmark there was a requirement for DFM to maintain

a one-to-one match between CMCs and accreditation scope. Dr Andres commented that the CCQM should move towards broader claims that are more customer orientated and that if possible this should use the same database used by the physical measurement community otherwise there was a danger of creating a division between chemical and physical measurement. Dr May replied that he thought it was not feasible to continue to fit biochemical claims into the same templates used for physical measurements. Dr Mester observed that the KCDB had served the NMIs very well until now, but a new way forward was now needed, however he cautioned against switching to a dramatically different system. Dr Mester recommended widening the scope of current claims and getting support and engagement from external organizations to do this. Further, he cited the JCTLM as a good example of where this approach had been successful. Mrs Parkes mentioned that bio-measurement needs are much more competence based, and therefore that option 2 and 3 would work for this area. However, Mrs Parkes cautioned that option 3 is only a 'front-end' solution and it was the 'back-end' CMC review and generation process that needed some work, especially defining what a broad CMC claim is and how confidence in such claims can be demonstrated. Dr Silva mentioned that the database was very complicated for the customer to understand and that a move to option 2 would improve this situation. Dr Silva went on to caution that option 3 represented a big change and that the customer base addressed by the JCTLM was very different.

Dr May brought the discussions to a close by summarizing that the CCQM needed to produce a position to take to the CIPM MRA review meeting in the autumn. Dr May expressed the opinion that currently part of the problem was that the community had not defined narrowly enough what a CMC is and what it is used for – for example, success should not be just associated with producing a large number of CMCs. Dr May suggested that based on the discussions in the meeting, the CCQM *ad hoc* WG on CIPM MRA review should modify the recommendations that they had already produced. Dr May advised that the WG should focus on the information that the KCDB should include for those that are envisaged to use it in the future, and that users should be able to search this data more effectively than is possible currently.

14. REPORT FROM THE AD HOC WORKING GROUP ON THE MOLE

Dr Güttler introduced the work of the CCQM *ad hoc* WG on the mole. The tasks of the group are to prepare a CCQM draft for the *mise en pratique* of the mole, a response to the CCU draft of the 9th edition of the SI Brochure, and a response to and input into any relevant IUPAC activities. The 5th meeting of the WG would take place following the CCQM meeting and Dr Güttler stated that most of the discussion on the *mise en pratique* would take place at that meeting; however he stated that the documents were freely available on the internet and encouraged attendees to read this and to send him comments. With respect to the *mise en pratique*, Dr Güttler stated that the current version incorporated the Avogadro experiment, was coordinated with the Consultative Committee for Mass and Related Quantities (CCM) to align with the *mise en pratique* for the kilogram, and was drafted so as to maintain continuity with the existing *mise en pratique*.

14.1. CCQM comments on the draft 9th SI brochure

Similarly to the *mise en pratique*, Dr Güttler stated that most of the discussion on the draft of the 9th SI Brochure would take place at the *ad hoc* WG on the Mole, however he stated that the draft was available on the internet and encouraged attendees to read this and to send him any comments. He also mentioned that the commenting deadline for the draft SI brochure had been extended to accommodate the CCQM meeting.

14.2 Outcomes of the meeting of the CCU WG on Angles and Dimensionless Quantities in the SI

Dr Mariassy summarized the recent outputs of the Consultative Committee for Units (CCU) WG on Angles and Dimensionless Quantities in the SI (CCU-WGADQ). It was reported that there had been some agreement to describe counting quantities with the unit '1' in a generic manner without invoking any new units as special names for '1' or to refer to the counting of entities. Whilst not of primary relevance to the CCQM, Dr Mariassy reported that there had been less agreement about the treatment of angles within the SI and this topic would need further discussion at a later date. There was also some discussion about whether 'dimensionless' quantities had the dimension '1' or actually had the dimension 'number'.

A draft text that had been prepared after the CCU WG meeting to cover such counting quantities for the draft 9th SI brochure was presented by Dr Mariassy. Further, he reported that it had been proposed that Mrs Parkes, Dr Brown and Dr Krystek had been asked to work together to finalize this text. Prof. Emons stated that he was not in favour of the term 'biomolecular or cellular entity' since it could cover anything. Dr Brown replied that this was the power of counting quantities, that they could cover collections of non-identical entities. Dr Güttler agreed and Dr Mariassy added that amount of substance and count of entities are not the same thing, they are different quantities. Mrs Parkes expressed the opinion that the SI brochure itself should remain concise but could then be supplemented by an 'examples document' giving suggested uses. Dr Milton replied that he thought that succinctness in the context of the SI brochure and that clarity in the brochure itself would probably be sufficient. Dr Ellison stated that he felt referring to dimension 'number' was confusing and results in reference to two 'numbers' in the expression of a measurement result. Dr Milton replied stating that Dr Ellison had confused the concepts 'pure number' and 'dimension number' and referred attendees to a recent paper in *Metrologia*, 2015, **52**, 297 by Dr Krystek which explained the difference.

15. MEMBERSHIP OF THE CCQM – APPLICATION PROCESS

Dr May reminded the CCQM that membership and observer status was decided by the CCQM President and the CIPM according to the guidelines laid down by the CIPM in document CIPM-D-01 '*Rules of procedure for the Consultative Committees (CCs) created by the CIPM, CC working groups and CC workshops*'. He also described a more detailed process (CCQM/15-39) for processing applications, which he had submitted to the CIPM for their consideration. Dr May welcomed HSA

and NIMT to the membership of the CCQM and referred to two applications for observer status that had been received during the year but that extra information was required from the NMIs involved before these applications could be progressed. Dr May added that guests could also attend the CCQM meeting on a case-by-case basis if invited by the CCQM President in that given year.

16. CCQM REPRESENTATION AT THE BIPM WORKSHOP ON MEASUREMENT UNCERTAINTY AND COMMENTS ON THE REVISED GUM

This agenda point was not discussed during the meeting.

17. REPORTS FROM THE RMOS

Reports on the status of the metrology in chemistry activities were given by the TC chairs from the RMOs.

Dr Botha summarized the activity in AFRIMETS. Whilst the majority of the work in metrology in chemistry was still taking place in South Africa there were now activities starting up in Kenya and Egypt and these countries now had CMCs in chemistry in the KCDB. She also noted the intention to collaborate with the BIPM in support of building capacity for mycotoxin metrology and analysis in foods in the region.

Dr Hwang presented the activities in the APMP region. It was noticeable that whilst the contribution to the KCDB from the APMP represented 22 % of all CMCs, in the chemistry area APMP contributed 32 % of CMCs. It was noted that the next chair of APMP TCQM would be Dr Liandi.

Dr Sega presented the work of the EURAMET TC-MC. It was noted that from June 2015 there would be new chairpersons of EURAMET (Dr Jeckelmann) and EURAMET TC-MC (Dr Andres) both from METAS. Dr Sega also introduced the new EMPIR framework for joint metrology research in Europe and explained how this programme would seek more industry and stakeholder involvement than previously.

Dr Cunha reported on the status of the SIM chemical metrology working group. He noted that within SIM chemical metrology is only represented by one group and does not have sub-groups to cover the various technical disciplines (such as gas, inorganic etc.) as is found in other regions. Dr Cuhna stated that Peru had recently received their first CMCs in chemistry.

Dr Kustikov introduced the activities of the physical chemistry section of COOMET. In particular it was stated that a CMC in electrochemical analysis had recently been accepted from Kazakhstan, the first from this country. The other CMCs in the chemistry are held by Russia, Ukraine and Belorussia. Dr Brown observed that there are several countries that are both members of COOMET and EURAMET and asked which RMO they use for their intraregional review of CMCs. Dr May said that in this case they would have the choice of either RMO.

18. REPORT FROM THE JOINT COMMITTEE FOR TRACEABILITY IN LABORATORY MEDICINE (JCTLM)

Dr Wielgosz gave a short report on the activities of the JCTLM. In particular he highlighted the recent survey of visitors to the JCTLM database. Dr Wielgosz stated that in contrast to the KCDB the vast majority of visitors (93 %) were not from NMIs. He further expounded on the content of the database, noting in particular that whilst almost all entries for certified reference materials come from NMIs, conversely almost all entries for reference measurement services (except for some from PTB and LNE) come from non-NMIs. He also noted that whilst traceability for trace elements and blood gases was usually to CRMs produced by NMIs, these materials had not been nominated for publication in the JCTLM database, and NMIs were invited to consider submitting entries related to these materials.

19. COMMENTS ON WRITTEN REPORTS FROM INTERNATIONAL ORGANIZATIONS IN LIAISON WITH THE CCQM

Dr Magnusson gave a short presentation of Eurachem's activities, in particular summarizing its achievements over the last 25 years since its formation in 1989 and the new guides that Eurachem intend to produce in the near future.

Dr Samuel gave a brief introduction to the aims and objectives of the Cooperation on International Traceability in Analytical Chemistry (CITAC), especially highlighting that it recently celebrated its thirtieth anniversary with a special meeting in Paris prior to the CCQM. Dr Samuel gave more details about the strategic planning process currently being conducted by CITAC and their plans for increased stakeholder engagement in the future.

No comments on other reports were forthcoming.

20. FUTURE CCQM WORKSHOPS

Dr Milton reported on two upcoming workshops that were relevant to the CCQM. The joint BIPM/VAMAS Workshop on "New Measurement Challenges in Materials Metrology" will take place at the BIPM during the week beginning 20 June 2016. The workshop will consider four themes in materials research, and will consider the new challenges for measurement science that are emerging in each of them: characterization of properties and effects of nanomaterials and systems, reliability of additively manufactured products, characterizing the lifetime and durability beyond CMOS technologies, and reliability of novel materials for protective systems. The outcomes of the workshop will include a report that summarizes the scope of the new challenges for measurement science in each of the four themes. It will also identify any requirements for additional coordination

between the BIPM and VAMAS to ensure that the necessary underpinning measurement traceability and infrastructure is available.

In the last week of June and first week of July 2016 the Italian Physical Society, INRIM and the BIPM will run a metrology summer school in Varenna, Italy, comprising three modules of 3 days each on: fundamentals of metrology, physical metrology and the fundamental constants, and metrology for the quality of life.

21. CCQM RESOLUTIONS

The 21st meeting of the CCQM produced no resolutions.

22. AOB

None.

23. DATE(S) FOR THE NEXT MEETINGS OF THE CCQM

Dr Wielgosz proposed the period between 15 April and 22 April 2016 for the next CCQM meetings at the BIPM, with the CCQM plenary meeting planned for the 21 and 22 April 2016.

23.1 CCQM WG meetings to be held during the second half of 2015

Dr May asked WG chairpersons to elaborate on their plans for WG meetings during the second half of 2015. Mrs Parkes, Dr Plant and Dr Park stated that the new bio-analysis WGs planned to meet at NIST, USA, in October 2015. Dr Sargent reported that the IAWG would meet in Teddington, UK, in November 2015. Dr Mackay stated that the OAWG would meet at NIST in October 2015 together with the new bio-analysis WGs. Dr Kim, Dr Mariassy and Dr Fujimoto reported that the GAWG, EAWG and SAWG did not plan to hold further meetings in 2015.

24. CLOSURE

In the absence of further business, the president of the CCQM closed the meeting at 1600 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 meetings and wished all attendees a safe journey home.

Dr R.J.C. Brown

Rapporteur, 30th April 2015

DECISIONS AND ACTIONS FROM THE 21ST MEETING OF THE CCQM

1. As rapporteur, Dr R.J.C. Brown to draft "Decisions and Actions" document and "Report of 21st Meeting of the CCQM".
2. CCQM approved the report of the 20th Meeting of the CCQM.
3. Outstanding actions from the 19th and 20th Meeting of the CCQM to be progressed (as detailed in CCQM/14-36 and CCQM/13-4).
4. Approval of the new WG structure including the new WGs in the bioanalysis area and their chairpersons, as detailed by the President in the meeting.
5. KCWG to consider unified nomenclature for the core comparison approaches being undertaken by different WGs to avoid confusion when communicating outside the CCQM.
6. Agreement to continue to hold WG meetings at the BIPM in association with the CCQM plenary meeting next April.
7. CCQM reiterated that for pilot studies the coordinating laboratory had the first option on publishing data, and required agreement from participating laboratories that their data could be published. Participants wishing to publish pilot study results in any way prior to the coordinating laboratory need to seek agreement from the coordinating laboratory.
8. Newly created CCQM WGs will work to update their strategy on the proposed two-year timeline (starting in April 2015); existing CCQM WGs will work to update their strategy on the proposed one year timeline (starting April 2016).
9. The *ad hoc* Steering Group on Microbial Measurements (MBSG) will continue to operate for the immediate future and any possible overlaps with the new WGs in the bioanalysis area will be assessed in due course.
10. Agreement that the wording of the KCWG statement about the implications of RMOs missing the submission deadline will be changed from "will be deferred to the next cycle" to "may be deferred to the next cycle".
11. The results of CCQM-K129 are to be expressed in SI units rather than "at%".
12. SAWG to determine in respect of the proposed comparison on surface area the relationship between the NMI in The Islamic Republic of Iran and the proposed guest laboratory RIPI from the same country.
13. Agreement to review the current CMC claims for surface area measurement by BET and similar methods, especially with regard to the traceability statement, with the review initiated by the KCWG Chair.
14. Noted that via Decision CIPM/104-26 the CIPM adopted the traceability exception related to delta value isotope ratio measurements proposed by the CCQM.
15. Noted the encouragement from the CIPM for the continuation of programmes within the NMIs to develop absolute isotope ratio measurement values.
16. Two GAWG task groups established as a result of the GAWG Particulate Workshop were approved: one to develop a roadmap towards comparable black carbon/elemental carbon measurements and one to develop a strategy for comparisons in the particulate area.

17. Noted the creation by the GAWG of a Task Group to review ozone absorption cross section data and recommend values and uncertainties to be used for BIPM.QM-K1
18. The *ad hoc* WG on CMCs to refine the proposed CCQM recommendation to improve the efficiency of the CIPM MRA, based on the discussions at the CCQM plenary meeting, and deliver these to the CIPM by mid-2015.
19. HSA (Singapore) and NIMT (Thailand) are welcomed to the membership of the CCQM.
20. The CCQM agreed to the proposals put forward in the CCU *ad hoc* WG on Angles and Dimensionless Quantities by using the unit '1' to deal with counting quantities in chemical and biochemical measurement.
21. The plans of WG chairs for WG meetings in the second half of 2015 were agreed.
22. The period 15 April to 22 April 2016 was reserved for CCQM meetings at the BIPM. A full timetable will be developed in due course. WG meetings will be hosted at the BIPM in this time period.

APPENDIX 1
WORKING DOCUMENTS SUBMITTED TO THE CCQM AT ITS 21ST MEETING

Working documents submitted to the CCQM at its 21st meeting are on restricted access.

Documents restricted to Committee Members can be accessed at the restricted website.

Document CCQM/	
15-01	Draft agenda of the 21st meeting of the CCQM April 2015, 2pp
15-02	Timetable of CCQM meetings April 2015, 1p
15-03	Draft summary report and recommendations from the *ad hoc* WG of future presentations of CMCs, R. Kaarls, 11pp
15-04	Visiting Scientist Opportunities in the BIPM Chemistry Department in 2016, R.I. Wielgosz, 3pp
15-05	Draft 9th SI brochure-open for comments, 29pp
15-06	Proposed revision of the GUM - open for comments
15-07	ISO REMCO report for CCQM April 2015, A. Botha, 3pp
15-08	ACS CCQM Workshop 19 August 2015 Abstracts
15-09	Draft *Mise-en-pratique* for the mole, 4pp
15-10	CIPM approved delta scale traceability exception, 1p
15-11	Opening comments of the CCQM President for the 21th Meeting of the CCQM Plenary, W. May, 31pp
15-12	Update of the CCQM Strategy Document (2017-2027), R.I. Wielgosz, 5pp
15-13	CCQM Key Comparison and CMC Quality Working Group, Della SIN, 25pp
15-14	Report of the MBSG April 2015, J. Morrow, 14pp
15-15	Report of the Surface Analysis Working Group, Wolfgang Unger, 33pp
15-16	Report of the Bioanalysis Working Group, Helen Parkes, 29pp
15-17	Report of the Electrochemical Analysis Working Group, Michal Máriássy, 43pp
15-18	Report of the Organic Analysis Working Group, Lindsey Mackay, 35pp
15-19	Report of the Inorganic Analysis Working Group, Mike Sargent, 18pp
15-20	Report of the Gas Analysis Working Group, Jin Seog Kim, 29pp
15-21	Introduction to the Nucleic Acid Working Group (NAWG), Helen Parkes, 7pp
15-22	Introduction to the Protein Analysis Working Group, Snag-Ryoul Park, 10pp

15-23 Introduction to the Cell analysis Working Group A. Plant, 6pp

15-24 CIPM approved traceability exception (SPWG/15-05 Decision CIPM/104-26), CIPM, 1p

15-25 BIPM Chemistry Department: 2015-2019 Work Program Update, R.I. Wielgosz, 43pp

15-26 Results of the CCQM Survey on future presentation of Chem/Bio CMCs, Robert Kaarls, 19pp

15-27 Possibilities for the future structure of Chem/Bio CMCs in the KCDB, R.I. Wielgosz, 1p

15-28 Report from the CCQM ad hoc WG on the mole, Dr. B. Güttler, 30pp

15-29 Information on outcomes of the meeting of the CCU WGADQ, M.Máriássy, H.Parkes, 5pp

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