



Consultative Committee for Mass and Related Quantities (CCM)

Report of the 20th meeting

(26-27 June 2025)

to the International Committee for Weights and Measures



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LIST OF MEMBERS OF THE CONSULTATIVE COMMITTEE FOR MASS AND RELATED QUANTITIES

as of 26 June 2025

President

Ms G. Macdonald, member of the International Committee for Weights and Measures also National Research Council of Canada [NRC], Ottawa.

Executive Secretary

Dr H. Fang, International Bureau of Weights and Measures [BIPM], Sèvres.

Members

Bundesamt für Eich- und Vermessungswesen [BEV], Vienna.

Central Office of Measures [GUM], Warsaw.

Centro Español de Metrología [CEM], Madrid.

Centro Nacional de Metrología [CENAM], Querétaro.

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

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

Danish Fundamental Metrology A/S [DFM], Hørsholm

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

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

Instituto Português da Qualidade [IPQ], Caparica.

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

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

Measurement Standards Laboratory of New Zealand [MSL], Lower Hutt.

National Institute of Metrological Research/Istituto Nazionale di Ricerca Metrologica [INRIM], Turin.

National Institute of Metrology [NIM], Beijing.

National Institute of Standards [NIS], Giza.

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

National Measurement Institute of Australia [NMIA], Lindfield.

National Metrology Institute of Japan, AIST [NMIJ/AIST], Tsukuba.

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

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

National Physical Laboratory [NPL], Teddington.

National Research Council of Canada [NRC], Ottawa, Ontario.

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig.

RISE Research Institutes of Sweden AB [RISE], Borås.

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

VSL Dutch Metrology Institute [VSL], Delft.

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

Official Observers

Industrial Technology Research Institute/Center for Measurement Standards [CMS/ITRI], Hsinchu.

Laboratorio Tecnológico del Uruguay [LATU], Montevideo.

National Metrology Centre, Agency for Science, Technology and Research [NMC, A*STAR], Singapore.

National Scientific Centre "Institute of Metrology" [NSC IM], Kharkiv.

1. OPENING OF THE MEETING

The Consultative Committee for Mass and Related Quantities held its 20th meeting at the International Bureau of Weights and Measures (BIPM) headquarters, at Sèvres, and on-line, on 26 and 27 June 2025.

The following attended:

Members

F. Arrhén (RISE), J. Abrantes (IPQ), H. Ahmedov (UME), R. Arias (CENAM), E. Batista (IPQ), H. Baumann (METAS), A. Beatrice (INMETRO), F. Beaudoux (LNE), M. Brown (NRC), A. Brzozowski (GUM), J.M. Calvo (CENAM), R. Crendal (NMIA), S. Davidson (NPL), A. Desoky Salama (NIS), S. Dignan (NMIA), S. Dlamini (NMISA), Y. Durgut (UME), D. El Haddad (NIST), K. Fen (NMIA), G. Fraser (NIST), Y.H. Fung (MSL), C. Garcia Izquierdo (CEM), S. Gelany (NIS), A. Gorchev (VNIIM/VNIIR), J.R. Graybill (NIST), R. Green (NRC), M. Hamdy (NIS), F. Härtig (PTB), I. Hernández (CENAM), S.K. Jaiswal (NPLI), H. Kajikawa (NMIJ/AIST), D.M. Kim (KRISS), M.S. Kim (KRISS), D. Knopf (PTB), A. Kumar (NPLI), N. Kuramoto (NMIJ/AIST), C. Kuzu (UME), K.-C. Lee (KRISS), E. Lenard (GUM), C. Li (NIM), V. Loayza (INMETRO), A. Lumbreras (CEM), G. Macdonald (NRC/CIPM, President of the CCM), D. Mari (INRIM), E. Massa (INRIM), T. Mautjana (NMISA), P. McDowall (MSL), M.J.T. Milton (Director of the BIPM), N. Murnaghan (NRC), B. Ndlovu (NMISA), A. Nekliudova (VNIIM), L. Nielsen (DFM), A. Nishino (NMIJ/AIST), P. Otal (LNE), L.M. Peña Perez (CENAM), A. Prato (INRIM), J. Robles (CEM), T. Schrader (PTB), M. Sej (GUM), I. Shmigelskiy (VNIIM), N. Singh (NPLI), L. Snopoko (SMU), I. Spohr (IPQ), W. Stiphout (VSL), D. Szabo (RISE), M. Thomas (LNE), D. Trochta (SMU), J. Wang (NIM), MY. Yang (NIM), Z. Zelenka (BEV).

Official Observers

S.-J. Chen (CMS/ITRI), S.M. Lee (NMC, A*STAR), L. Lu (NMC, A*STAR), W.H. Ng (NMC, A*STAR), S. Preste (LATU), V. Skliarov (NSC IM), Y.-H. Wu (CMS/ITRI).

Representatives of Institutes from Member States invited to attend as Meeting Observers

N. Al Menhali (EMI), J.J. Escobar Soto (INM Colombia).

Guests

D. Eppers (PTB), D. Hutzschenreuter (PTB), A. Knott (NPL), F. Menelao (PTB), B. Mickan (PTB), D.B. Newell (NIST), K. Ogushi (NMIJ/AIST), A. Possolo (NIST), D. Pražák (CMI), T. Rubin (PTB), J. Scherschligt (NIST), M. Wozniak (RISE), S. Wu (NIM).

Also present

F. Bielsa (BIPM), P. Da Silva Conceição (BIPM), H. Fang (BIPM, Executive Secretary of the CCM), A. Kiss (BIPM), S. Maniguet (BIPM, KCDB Coordinator), F. Meynadier (BIPM), M. Stock (BIPM), K. Yamazawa (JCRB Executive Secretary).

President of the CCM, Ms Georgette Macdonald welcomed participants and opened the 20th meeting of the CCM. During the welcome the participant statistics of the session were noted with almost 100 participants in the meeting (60 in-person) containing at least one

representative from all 27 Members, four Observers, with the addition of guests and staff of the BIPM.

Ms Macdonald notified participants that the meeting was being held in hybrid format. The meeting was recorded to support the work of the rapporteur, to be confirmed during the next agenda item as Dr Green (NRC).

Ms Macdonald presented the agenda and noted the technical workshops being held each day, alongside the regular CCM meeting.

Day 1, 9:00 – 18:00, UTC+2

2. Appointment of a Rapporteur and Approval of the agenda
3. News from the CIPM and the BIPM
4. Actions arising from the 19th meeting of the CCM
5. Report of the CCM Working Group on Strategy and MRA coordination
6. Reports of the CCM technical Working Groups
Workshop: Session I on Pressure and Vacuum
7. Report of the CCM-TGPfD-kg
8. Report on the work programme of the BIPM mass laboratories
9. Presentation in support of Observership application: INM Colombia

Day 2, 9:00 – 13:00, UTC+2

10. Updates from JCRB and KCDB
11. Reports from RMOs
12. Decisions and actions
13. Next meeting and any other business
Workshop: Session II on Key Comparisons and Digitalization
Adjourn.

Optional visit of the BIPM Kibble balance laboratory

2. Appointment of a Rapporteur and Approval of the agenda

During the opening presentation Ms Macdonald requested approval for both the rapporteur (Dr Green) and the agenda. No objections were noted amongst participants, and both were confirmed as approved. Ms Macdonald requested submission of NMI reports from the two remaining NMIs who had not yet submitted them. NMI reports are noted and included in the meeting material but not discussed in the plenary session.

3. News from the CIPM and the BIPM

Ms Macdonald presented an update on decisions of the CIPM, providing a link for all [meeting outcomes](#) (Decisions), summarizing the main ones since the last CGPM meeting in 2022:

3.1. Updates from the CIPM

- Decision CIPM/112-22 (2023): Accepted the following changes to the membership of the CCM, include NIS (Egypt) and UME (Türkiye) as members.
- Decision CIPM/112-23 (2023): Approved the Final Draft of the document JCGM GUM-1:202X (Guide to the expression of uncertainty in measurement — Part 1: Introduction).
- Decision CIPM/113-29 (2024):
 - Endorsed *Metrologia* as its journal of choice for reporting advances in pure and applied metrology at the highest level, including by NMIs and under the auspices of the CIPM's Consultative Committees and Forums.
 - The CIPM asked the Consultative Committees and Forums to nominate one or more ambassadors to *Metrologia*.
 - The CIPM asked the BIPM to pursue an Open Access publishing model for the journal.
 - The CIPM recommended the creation of a separate entity for the publication of comparison reports and asked the BIPM to implement an appropriate mechanism.
- Decision CIPM/112-25 (2023): The CIPM adopted "Forum on Metrology and Digitalization" as the name for the horizontal forum on digitalization. It adopted the mission and structure of the forum and approved the BIPM updated workplan on digitalization for 2023 and 2024.
- Decision CIPM/113-10 (2024): The CIPM decided that the 28th meeting of the CGPM will be convened during the week beginning 12 October 2026 and that it will be organized over three days.
- Decision CIPM/113-21 (2024): The CIPM approved a new version of the 9th edition of the SI Brochure (v3.01).
- Decision CIPM/114-5 (2025): The CIPM approved the proposal of the Selection Committee for the final candidate for the next Director with 18 votes in favour and one abstention.
(Ms Macdonald noted Dr Annette Koo from MSL (New Zealand) had been appointed by the CIPM as Director Designate of the BIPM, succeeding Dr Milton upon his retirement).
- Decision CIPM/114-7 (2025): The CIPM decided that a Member State that is suspended may be represented at CGPM meetings but shall not be entitled:
 - to vote
 - to receive calibration services from the BIPM
 - to participate in international comparisons organized by the BIPM
 - to publish new CMCs in the KCDB
 - for their representative to stand for election or re-election to the CIPM, though they may attend meetings

(Ms Macdonald noted that no states are presently suspended).

- Decision CIPM/114-13: The CIPM decided to establish a CIPM Task Group on Quantum Technologies for Metrology to draft the objectives and terms of reference for an envisaged horizontal activity.
(Ms Macdonald has volunteered to be a member of the task group)

3.2. Updates from the BIPM

Dr Milton presented the status of the organization indicating that as of May 2025 there are 64 Member States and 37 Associates of the CGPM, with Cuba reinstated in October 2024. No members are currently suspended or expected to be suspended in the coming year. He summarized statistics of CIPM MRA participation which totalled 258 participants including members and associates, international organizations (4), and designated institutes (157). There are 26 135 CMCs, 1 956 comparisons (1 224 key), and six regional metrology organizations.

Dr Milton reiterated the appointment of Dr Koo who will succeed him as BIPM director upon his retirement, Dr Koo will join the BIPM on 22 September 2025. Further, Dr Kazuaki Yamazawa (NMIJ, AIST) was appointed by the BIPM as the new Executive Secretary of the JCRB.

Dr Milton described efforts of the JCGM towards a fourth edition of the VIM in which “measurement uncertainty” could be redefined, with one informal proposed definition being: “doubt about a value of the measurand that remains after making a measurement”. He communicated the JCRB will be looking for input in this regard.

Summarizing the status of the Journal Metrologia, Dr Milton highlighted news that comparison reports will be published on-line by the BIPM, and it is planned that Metrologia will become fully OPEN ACCESS on 1 January 2026. He expected that the change should positively impact the citation rating of the journal.

The BIPM celebrated its 150th anniversary in 2025. There were celebratory events at the UNESCO headquarters and Versailles during the week of 20 May. An anniversary book was published, which is on sale for twenty-nine Euro. Other gifts and letters of thanks were received and the BIPM commissioned memorial vases that are for sale to NMIs, nine have been sold so far. Other highlights include interviews and features in the media including France 24, Le Figaro, and Illumination of La Mole in Turin, Italy. UNESCO has expressed an offer to include “metrology” in its educational outreach programme.

Dr Milton finalized his talk by discussing the interest of the BIPM in engaging more states in its work towards universal adherence to the Metre Convention. Presently 84 UN states do not participate, though 13 presently have a UN coefficient greater than 0.02 and would benefit from Associate or Member status. He discussed plans to engage the remaining 71 UN states whose UN coefficient is smaller than 0.02 (CIPM criteria) through the proposed creation of a new status of Observer State which would allow some level of participation without requiring financial contributions.

4. Actions arising from the 19th meeting of the CCM

Ms Macdonald thanked Dr Milton and moved to discussion of actions arising from the 19th meeting. These were noted as being completed and summarized as follows:

WGM

- Collect feedback from WG members and decide 3rd CCM.M-K8 schedule.

TGPfD-kg

- Make proposal to change the way the KC results contribute to the next Consensus Value.
- Establish strategy to address the lack of agreement between current realizations of the kilogram.

CCM President

- Make recommendations to the CIPM on two CCM Membership applications.

5. Report of the CCM Working Group on Strategy and MRA coordination

Ms Macdonald presented an update from the WG Strategy based on the meeting which took place on Wednesday 25 June at the BIPM headquarters. The meeting included:

- Reports from WGs and TGs
- Reports from RMOs
- Work programme of the BIPM mass laboratories
- Taking note of the reports from the JCRB executive secretary and the KCDB coordinator
- Discussion on CIPM MRA matters
- Approval of the CCM action plan 2025-2026
- Decision to create of a Task group on dynamic measurements.

The task group's work will initially be to develop terms of reference and in the future to evaluate whether a working group should be created. A call was placed for anyone who may be interested in contributing to the task group, those interested should contact Ms Macdonald and the CCM Executive Secretary Dr Fang.

6. Reports of the CCM technical Working Groups

Ms Macdonald progressed the meeting to the next agenda item which includes reports from each working group, given by their respective chairs.

6.1. Report of the working group Density and Viscosity (CCM-WGDV)

The report was presented by Dr Eppers (PTB) who noted that there had been two working group meetings since the last CCM, a presentation delivered during a webinar on WG activities on 22 May 2024 and again, within the past week (23 June) onsite at the BIPM. There were 55 participants for density and 44 for viscosity representing 29 members and eight observers. The Objectives of the WG were summarized and are related to organizing, approving, and reviewing KCs and supplementary comparisons,

harmonizing CMCs, supporting development of dissemination techniques in density and viscosity. Services covered within the density area are density of solids, liquids, and refractive index of liquids. Services in the viscosity area are Newtonian reference liquids (certified) and their measurement, capillary viscometers, with a new pilot study in surface tension in development.

6.1.1. Progressing the state of the art

Dr Eppers highlighted some technology trends within the WGDV:

- Harnessing developments from the redefinition of the kilogram, reduction in density measurement uncertainty of silicon spheres by hydrostatic weighing
- Extending hydrostatic techniques to smaller density standards (e.g. 30 mm silicon spheres)
- Development of a hydrostatic weighing system for disseminating density using pressure stabilized weighing, comparing natural silicon spheres directly to Si28 spheres
- Improve density measurement capability across wide pressure and temperature ranges
- Traceable reference liquids and measurement technology for surface tension and refractive index, particularly for the food and agriculture industries
- Viscosity measurements of non-Newtonian liquids.
- New technologies enabling improvements in measurement and standards for viscosity
- Digitalization of calibration certificates, capability already developed at some NMIs.

6.1.2. Liaisons and Stakeholders of the WG

Dr Eppers indicated the WGDV liaisons with IMEKO TC3 and, for refractive index of liquids, with Consultative Committee Photometry and Radiometry.

The main stakeholders of the working group include:

- Energy, alcohol, food, and materials industries
- Measuring instrument manufacturers
- Reference standard producers and calibration/testing laboratories.

6.1.3. Key Comparisons and CMCs

Dr Eppers summarized the list of ongoing and planned key comparisons within the working group and their status as follows:

Ongoing Key Comparisons:

- CCM.D-K1.2023 (Density measurements of 1 kg Si sphere) - Pilot: PTB, eleven participants, Draft A in progress, to be completed in 2025
- CCM.D-K3 (Density measurements of stainless-steel weights) - Pilot: NMII, 15 participants, measurements in progress, tentative planned completion in 2026, significantly delayed at present

- CCM.D-K5 (Density measurements by oscillation-type density meters) - Pilot: BEV, 17 participants, measurements completed, Draft A in preparation, completion planned for 2025, behind schedule due to shipping and packaging issues
- Two pilot study of surface tension of liquids at CCM/EURAMET and SIM - Pilot: GUM, EURAMET/CCM, to commence in 2026 and Pilot: CENAM, SIM
- CCM.V-K4.A / CCM.V-K4.B (Viscosity measurements of standard liquids) - Pilot: CENAM, 12 participants, Approved for equivalence in 2025.

Planned Key Comparisons (approved CCM/2023/2021):

- CCM.V-K5 (Viscosity of standard liquids across a wide range) - Pilot: NIM, questionnaire phase, to commence 2026
- CCM.D-K2 (Liquid density by hydrostatic weighing)- Pilot sought
- CCM.D-K4 (Calibration on high-resolution hydrometers) – Pilot LNE.

The working group will also begin reviewing and updating CMCs and service categories with completion planned for 2026. While still under discussion, this effort will likely include the simplification and reduction of the number of CMC entries for viscosity (kinematic and dynamic viscosity).

6.1.4. Proposals of the WG

Since 2025 the chair and co-chairing roles have been divided along technical areas with Dr Daniela Eppers the chair (density), and Dr Zheng Dong Zhang (NIM) the vice chair (viscosity), which is aligned with their expertise. The roles should be formally approved during the 20th CCM Meeting.

Dr Eppers presentation closed with the proposal to accept new membership to the WG from three institutes. Each of the institutes had provided a presentation during the most recent WGDV meeting which strongly supported their case. The institutes and presenters proposed for admittance to the working group were:

- KEBS (Kenya) Wilson Ombati/ Beatrice Lugadiru
- NMIT (Thailand) Chompoonoot Hirunyapruk
- NMIM (Malaysia) Zulkhairi Bin Anuar/ Noor Razinah Binti Rahmat

6.1.5. Decisions taken

Following the presentation of Dr Eppers, Ms Macdonald sought formal approval for all proposals including for chair and co-chair, comparison CCM.D-K6, and the new memberships to the WGDV. Each were left for objection in turn, and as there were none, the proposals were accepted in full. Ms Macdonald welcomed the new members to the working group.

6.2. Report of the working group Force and Torque (CCM-WGFT)

Mr Knott (NPL) presented the report for the WGFT which had held two virtual meetings since the last CCM meeting. These were held on the 6–7 February 2024, and the 18–19 February 2025. A virtual meeting was also planned for February or March 2026. It was noted that holding virtual meetings allowed them to be held more frequently, compared to previous in-person meetings held every three years, and attendance to the virtual meeting was also comparatively higher. As a result, meetings will continue to be held virtually once per year.

6.2.1. Actions and achievements:

The working group wrote and published online on the working group site a document entitled *“Guidelines for the Submission and Review of Calibration and Measurement Capabilities”* as well as a complementary Excel template to support the submission. The approach was adopted from the WGFF and WGPV and offers guidance on how much evidence is required to support CMCs depending on the risk/difficulty associated with the CMC. The difficulty was divided into levels 1-3 of decreasing difficulty which are defined by the CMCs traceability method, force/torque range, and the associated uncertainty claims. For each difficulty level there is a points-based system which assigns points for specific types of information provided as evidence, with 16 points for fully documented uncertainty budget the largest value, to 2 points for “other” evidence. Difficulty levels 1-3 range in points required from 36-28 respectively. Within this point structure a fully documented budget is always required for each level regardless of other evidence provided. Mr Knott continued with detailed description of the working of the template, showing examples from it. Both the guidance document and associated template are available on the BIPM website within the [CCM-WGFT](#) area.

6.2.2. Progressing the state of the art

Mr Knott highlighted some technology areas of interest for future development and associated collaborative European research project, pursuing some of these activities. These are summarized:

- Methods for continuous and dynamic force calibration, will participate in planned dynamic measurements task group
- Development and optimization of technology including digitalization
- Digital SI and Digital Calibration Certificates (DCCs) in force and torque
- Methods for realization of low-range force and torque with direct traceability to fundamental constants, using Kibble type principle
- Traceability for time-dependent forces in different frequency ranges
- Traceable machines for continuous and dynamic measurements in different frequency ranges for testing in industry and research
- EMPIR 18SIB08 ComTraForce :
<https://www.ptb.de/empir2018/comtraforce/home/>
- Torque measurement under rotation and dynamic torque

- Traceability for large torque in the MN m range
- Traceable methods for mechanical power measurements and efficiency determination
- More interdisciplinary new topics for example in the field of renewable energy, EMPIR 19ENG08 WinDEFcy:
<https://www.ptb.de/empir2020/windefcy/home/>.

6.2.3. Liaison and stakeholders

WGFT liaises with IMEKO and ISO technical committees as follows:

- IMEKO TC3 – Measurement of force, mass, torque, and gravity
- ISO/TC 164 – Mechanical testing of metals
 - ISO/TC 164/SC 1 - Uniaxial testing
 - ISO/TC 164/SC 1/SG 1 - Continuous force traceability (ISO 376 and ISO 7500-1).
 - ISO/TC 164/SC 4 - Fatigue, fracture and toughness testing.

The WG and technical committees with which it liaises supports the interests of industrial stakeholders such as:

- Manufacturers of force and torque measuring devices
- Manufacturers of testing machines and test benches
- Calibration and testing laboratories in force and torque
- Automotive, aerospace, materials, offshore, renewable energy industries
- Automation technology
- Medical measuring techniques.

6.2.4. Key Comparisons and CMCs with the working group

Mr Knott presented a graph of force versus uncertainty illustrating the range of values covered by CMCs within the force area and the five key comparisons that support them. The group has decided “how far the light shines” for these KCs, and the plot demonstrated that there is a range of CMCs particularly below 10 N that are not covered by any KC. Mr Knott indicated this will be an area to address in the future. A similar plot was also presented for torque indicating some CMCs below 1 N m are also not supported by any KCs, and this could be an area for development.

Mr Knott summarized the status of recently completed, ongoing and completed KCs:

Completed KC

- CCM.F-K23 (200 N, 500 N) - Pilot METAS

Ongoing KC

- CCM.F-K1.a.2022 (5 kN, 10 kN) - Pilot UME

Planned KCs

- CCM.F-K4 (2 MN, 4 MN) - Pilot NIST, technical protocol complete
- CCM.T-K1 (500 N m, 1 kN m) - Pilot CEM
- CCM. T-K3 (20 N m, 50 N m) - Pilot PTB.

The programme of work for the next two years was described by Mr Knott and largely comprised the completion of the ongoing comparisons summarized above and the commencement of those planned. Exploratory work had begun to develop a new comparison in the 1 N–20 N range with expanded uncertainties between 20 ppm and 100 ppm, with fourteen laboratories expressing interest. Mr Knott felt it likely that issues finding transfer standards of sufficient quality to support the comparison was a significant technical barrier to performance. He speculated that this challenge was linked to the ongoing difficulty of finding a Pilot for the comparison, with none of the interested parties having yet volunteered for the role.

Upon completion of the presentation Ms Macdonald opened the floor to questions. Dr Milton congratulated Mr Knott on the quality and utility of the plots he presented regarding KCs and CMCs. With his intention to highlight these plots for attendees Dr Milton asked what the stakeholder's/user's perspective would be regarding the need for CMCs, and in which range they may be. Mr Knott replied that from his experience at NPL, users are generally very happy with existing CMC ranges and levels though there has been some expressed interest that cannot be satisfied at the very high end of force (tension) within the 10 MN–30 MN range. With the issue being the lack of facilities capable of those extreme values, rather than the level uncertainty of the available services approaching them.

6.3. Report of the working group Gravity (CCM-WGG)

Dr Wu (NIM) presented the report for the WGG. The WG had held two meetings, one online on 26 September 2024, which was attended by thirteen working group members and one invited observer. The meeting largely focused on discussion of draft B of the CCM.G-K2.2023 key comparison of absolute gravimeters, which resulted in its subsequent approval and the publication of the final report in 2024. The second meeting was held in hybrid format on 23 June 2025, and was attended by sixteen WG members and five invited observers. The meeting discussed instrumentation and applications of gravimetry, published CMCs and the need to harmonize their terminology, preparation of WGG guidelines and statements. It was decided that the next meeting scheduled for 2026 would finalize the pilot laboratory and host site for the next KC to take place in 2029.

6.3.1. Main actions and achievements

Dr Wu described the completion of the CCM.G-K2.2023 Key Comparison of absolute gravimeters and associated regional comparisons. The key comparison had been hosted by NIST (Boulder, Colorado, USA) between August and September 2023 at the Table Mountain gravity observatory. Across the timespan thirty gravimeters (27 FG5/FG5X, 1 NIM-3A, 2 atom) were compared, in several groupings, representing 27 institutes including 15 NMIs/DIs. Each grouping could have as many as eight participants, representing the number of available piers upon which measurements could be performed. A set of three relative gravimeters (gPhoneX) were

used to continuously monitor the gravity change across the length of the comparison to link all measurements in time.

The two atom gravimeters that participated in the comparison were from NIM (China) and the Chinese Academy of Sciences. The measurement results were effectively divided into two comparisons for analysis; one which included only the results of NMIs/DIs (the KC) and a second comparison including all 30 gravimeters. For both comparisons the results showed excellent agreement across all gravimeter types and models.

Dr Wu described the linking of RMO comparisons to CCM.G-K2, no RMO comparisons were required in SIM or APMP because their needs were satisfied directly by the CCM KC. EURAMET held a regional comparison designated as EURAMET.M.G-K2.2023, it was piloted by VÚGTK (Czechia) and hosted by the Geodetic observatory Wettzell (BKG, Germany) in 2024. Draft B was presented in June 2025 and linked to CCM.G-K2.2023 through three laboratories and all participating gravimeters demonstrated equivalence.

The guidance document “Note for comparisons of absolute gravimeters” had been prepared and accepted by the working group and is now published on the BIPM Website in the WGG area.

6.3.2. Progressing the state of the art

Dr Wu presented the trending areas of development in gravity metrology, this included improvements to the uncertainty of FG5/FG5X absolute gravimeters, which are already considered the most accurate in the field. Here, newly determined corrections related to signal distortion/dispersion, Coriolis force, and verticality are expected to improve uncertainty down to slightly below 2 μGal (~ 2 ppb). Additional development is expected in the area of cold-atom (quantum) gravimetry, and quantum gravity gradiometers which can simultaneously determine gravity acceleration and its vertical (height) gradient.

6.3.3. Liaison and stakeholders

The working group maintains continuous cooperation with the International Association of Geodesy (IAG) through various subcommittees and working groups, namely:

- IAG SC 2.1: Land, Marine and Airborne Gravimetry
- IAG JWG 2.1.1: Establishment of International Gravity Reference System and Frame
- IAG WG Q.1: Quantum gravimetry in space and on ground.

Additionally, WGG works with IMEKO TC3 (Force, Mass, Torque and Gravity), and supports the realization of the related units and ensures the gravity units are traceable to the SI.

6.3.4. CMCs and Programme of work

Dr Wu noted that there are presently a total of fourteen CMCs within five different RMOs, they are mainly using free-fall methods for direct absolute gravity determination with three CMCs using a comparison method with respect to the value of a gravity reference station. Four of these CMCs had been added in the past two years.

The upcoming programme of work is expected to cover the following items:

- Improvement of CMCs (increase number of CMCs and update technical specifications)
- Publish guidelines on the submission of CMCs, and the evaluation of key comparisons
- Digital calibration certificates for gravimeters
- Investigating and resolving possible systematic differences between classical and atomic absolute gravimeters
- Validation and calibration of various gravimeter types using reference stations of the International Gravity Reference System.

6.3.5. Proposals

Dr Wu explained that membership in the working group can be both institutionally based or personally based. He proposed the removal of LGUL (Luxembourg) as an institutional member as they are no longer active, and the addition of PTB (Germany) as new member institute. Likewise, Dr Reinard Falk (BKG, Germany) a personal member has retired and Dr Hartmut Wziontek (BKG, Germany) was proposed to take over his membership.

Upon completion of Dr Wu's presentation Ms Macdonald opened the floor to questions and Dr Kuramoto (NMIJ/AIST) asked for confirmation that the next K2 key comparison would occur in 2029. Dr Wu confirmed the year clarifying that it is due the six-year period assigned to this KC, with the last taking place in 2023.

Ms Macdonald formally sought endorsement for the addition of the proposed new members to the working group. As there were no objections the new memberships were approved and welcomed by Ms Macdonald to the group.

At this stage, the morning session was completed. The planned technical *Workshop: Session I on Pressure and Vacuum*, would take place after the break.

6.4. Report of the working group Fluid Flow (CCM-WGFF)

The chair of the WGFF, Dr Mickan (PTB) was invited to present the report for the WGFF.

Three online or hybrid meetings had been held, the first on 25 March 2024 involving only the WGFF and RMO TC chairs in flow. This was to discuss priority work items of the TCs. The second online meeting was held the on 28–29 October 2024 for two hours each day, and the third meeting (hybrid) held during the week of the 20th CCM meeting on 24 June. The next meeting will be held in May 2026 in-person only in Tsukuba (Japan) in conjunction with Flomeko.

6.4.1. Main actions and achievements

Dr Mickan summarized the main actions and achievements from each RMO, including an update on the respective chairs of each RMO and a detailed description of their main activities including meetings, comparisons undertaken, regional projects, CMCs and their reviews within the RMO organizations. Of particular note:

- AFRIMET: Thomas Mautjana is the contact for TC-M with Bonganu Ndlovu the hardness subcommittee member, contacts had been difficult to obtain but have recently been updated
- APMP: Held two meetings of the TC in 2023 (China) and 2024 (India), five peer reviews were completed in 2024 and a special workshop on primary calibration systems in developing economy countries' (DEC) NMIs was held. There are six RMO comparisons and two supplementary comparisons ongoing in the region
- COOMET: Held five meetings, and four supplementary comparisons are ongoing with four more planned. There have been 26 peer reviews and one new CMC presently under review
- EURAMET: The most recent TC meeting was held in April 2025 in Spain, and the main activities of the RMO are represented by eleven comparisons, two research projects and one consultation which are in progress or ongoing. The TC supported knowledge transfer through organization in TC Flow summer school (9–13 September 2024)
- SIM: Six regional comparisons are in active progress, and a database of experts was developed to support the review of CMCs. The next SIM WG/TC meeting is tentatively planned to be hosted by LCM (Costa Rica), details to be determined.

6.4.2. Progressing the state of the art

Technology areas of focus within the WG were noted to be in two main categories:

- De-carbonization of the energy supply in which production, distribution and consumption are relevant measurement areas for fuels such as hydrogen and synthetic/bio-fuels, additionally of particular interest in EURAMET is in Carbon Capture Use and Storage (CCUS) and balancing flow in the transport networks which requires leak and flare quantification of the relevant gases (CH₄, H₂, CO₂) in which metrology should support regulation and standardization.
- Extension of fields of application and sensor technologies in:
 - Micro flow, organ on a chip which represents artificial biological systems in which new micro flow measurements are relevant
 - Dynamic flow, in which measurements need to be performed accurately under a large range of conditions, which results in high rate of fluctuation

- Multiphase flow and wastewater areas are older and less active but remain relevant
- Meter diagnostics and sensor networks are becoming areas of increasing interest since companies are acquiring significant information/data from these systems which should be used appropriately and beneficially.

6.4.3. Liaison and stakeholders

The working group engages regularly with various IMEKO and ISO technical committees:

- IMEKO TC9 (flow)
- ISO TC 48 (Laboratory equipment) and TC 28 (Petroleum and related products) EURAMET TC-F is directly linked through a type A liaison.
- ISO TC 30.

Other stakeholders include the legal metrology organization OIML TC 8, and accreditation organizations from most of the participant countries in the WG.

6.4.4. CIPM MRA: KCs and CMCs

Dr Mickan summarized the status of key comparisons as follows:

- CCM.FF-K2.2011 (Hydrocarbon liquid flow) – Pilot VSL, Draft B delayed
- CCM.FF-K5.2021 (High pressure gas flow) – Pilot PTB, Draft A
- CCM.FF-K1.2022 (Micro flow of water) – Pilot METAS, published
- CCM.FF-K1.2024 (Large water flow) – Pilot PTB, measurements in progress
- CCM.FF-K3.2025 (Air Speed/ LDV fringe spacing) – Pilot: PTB, to be registered
- CCM.FF-K4.2025 (Micro pipettes) – Pilot: IPQ, planned to start

A pilot study is in preparation for the comparison of mobile gravimetric systems for H₂ used as references to approve re-filling stations. The work is technically difficult, and the transfer standards need to be studied as the mobile stations themselves are large and not sufficiently mobile to be transported around the RMOs for the comparison. It is unclear at this point if the work will be completed before the next CCM meeting.

CMCs are being clarified, and it is being proposed that CMCs in molar flow should be moved to the WGPV where all the related technical work and expertise reside, therefore aligning the CMCs with the experts able to review their submission. In the interim period before they are moved, “guest reviewers” from WGPV have been appointed to provide support. This work underscores other potential issues where CMCs presently housed under one WG actually span the technical areas of multiple WGs.

6.4.5. Programme of work for the next two years

- Continue effort to objectively apply KC results to the review of CMCs, an appendix B to the CMC review protocol addressing “how far the light shines” is expected in draft form by January 2026, with approval by the WGFF targeted for May 2026
- Method development utilizing Bayesian Hypothesis testing in comparisons to support the evaluation of CMCs
- Meeting coordination with Flomeko and additional online meetings in support of ongoing work
- Preparation of comparison technologies to support key comparisons and CMCs required for de-carbonization activities.

6.4.6. Proposals

To close his report presentation Dr Mickan reiterated his proposal to shift CMC entries in molar flow to the WGPV where they were once held.

Ms Macdonald opened the floor to questions and Dr Shmigelskiy (VNIIM) enquired as to the status of VNIIM’s request to become a member of the WGFF and what the next steps were. Dr Mickan replied that process was under review given the non-unanimous voting during the most recent WGFF meeting. The question on how to manage this situation would be addressed during the summer with the WG chairs and CCM president.

Dr Milton asked what the status was on moving the CCMs for Molar flow from WGFF to WGPV. Ms Macdonald replied that this was discussed during the WGS meeting and with agreement of both WGs would proceed. Dr Milton noted that the next steps should be to notify the JCRB and KCDB.

In a follow up question Dr Milton noted that CCM.FF-K2.2011 measurements had been performed between 2013-2015, and he questioned why the draft B was so long delayed and what would the plan be to either complete it or abandon it. Dr Mickan replied that the reason for the delay was that the scientists originally responsible for the comparison are no longer available or accessible. However, given the draft B deadline was only a few weeks (18 July 2025) away, it would be best to wait for that deadline to be reached before deciding how to proceed. Dr Milton suggested that given the delay and its impact on performance metrics for the JCRB and the community in general, abandonment is a reasonable option should the comparison continue to be delayed, he asked that the CCM president be notified of the status after the deadline had been reached.

6.5. Report of the working group Hardness (CCM-WGH)

Dr Menelao as chair was invited to present the report of the working group on hardness. He commenced by noting that two meetings had been held since the last CCM meeting, one at the ASTM headquarters near Philadelphia (USA) in 2023 and a second in Tsukuba (Japan) in 2024. The next meeting is planned for 19 September 2025 at UNM, in Paris (France) around the time of the ISO TC 164 meetings.

6.5.1. Main actions and achievements

The Working group has completed the reports of the last comparisons and pilot studies and planned the next key comparisons. Ongoing work was to revise and standardize the way CMCs are categorized and reported in the KCDB. He presented two different possibilities that have been developed in the branch of hardness, with different services, sub-services and individual services (representing the range). In total approximately 180 entries would be required to represent the range of services in these categories.

- Updates to the Guidelines on the Estimation of Uncertainty in Hardness Measurements (Version 2.0, 03/2011) have commenced to revise uncertainty calculations and expand to new scales (e.g. HRC hardness)
- NIMT (Thailand) has established and validated an ISO 14577-1:2015 compliant instrumented indentation hardness testing facility
- Within GULFMET a project for the "Development of Transfer Standards for Traceability of Hardness Diamond Indenter Calibration Systems" is ongoing and has been funded by GSO.GULFMET and Coordinated by TÜBİTAK UME. Its aim is the production and characterization of transfer standards to be used to establish traceability for Rockwell and Vickers hardness diamond indenter calibration systems of the NMIs in the GULFMET region.

6.5.2. Progressing the state of the art

Work is ongoing to Define the exact parameters of indent types, particularly where indentation causes disturbance to the material so that it is difficult to represent by a simple quantity such as height and width, since the start and end points might not be clear. More refined definitions to find the edge of an indent are in development within a EURAMET project called [TracInd BNK-H](#).

6.5.3. Liaison and stakeholders

Dr Menelao summarized the committees with which the working group liaises and its main stakeholders in industry:

Technical committees

- IMEKO TC5 - Hardness Measurement
- ISO/TC 164 Mechanical testing of metals.

Industry

- Manufacturers of hardness testing machines
- Calibration and testing laboratories in hardness
- Steel, automotive and aerospace.

6.5.4. CIPM MRA: KCs and CMCs

Dr Menelao summarized the comparison under active progress or development as follows:

- Pilot study of Leeb hardness, LD and HLG scales

- APMP.M-H2.2024 (Rockwell Hardness 30 TW)
- APMP.M-H1.2024 (Rockwell Hardness 30 N)
- CCM.H-K3 (Rockwell C hardness, HRC) is being reinitiated by splitting into two KCs, since due to global political situations not all NMIs can work with each other. There will be sufficient overlap to ensure equivalence can be demonstrated across both KCs.
- Considering new key comparisons in:
 - Geometrical Measurement of the Rockwell Diamond Indenter.
 - Rockwell N
 - Brinell (HBW scales to be determined)
 - Leeb hardness (once pilot study is complete)
- One pilot study on geometrical measurement of Vickers and Knoop diamond indenters is being considered.

6.5.5. Programme of work for next two years:

- Develop additional test definitions for Brinell and Rockwell hardness
- Develop unified format for reporting hardness CMCs
- Overcome some of the scheduling difficulties encountered in recent years and initiate some of the new key comparisons under consideration
- Finalize the definitions related to locating the edge of an indentation
- Determine sensitivity coefficients for hardness measurements' related influence factors in indentation instruments such as illumination, focus point, holding period and temperature.

Dr Menelao completed his presentation by noting a change in membership to the working group, with NIST representative Dr Ami Ahure Powell taking over for Mr Carlos Beauchamp.

Ms Macdonald requested questions at this point, and Dr Hartig (PTB) thanked Dr Manelao for his interesting presentation and asked if he thought that there could be a systematic effect on current measurements in hardness given the current difficulty finding the edge of an indent. Dr Menelao replied that the main problem is that there is no definition at all, so some labs may be choosing different points to define the edge. Different selection could, for example, result in variations of 1 μm or 2 μm which can in-turn impact the hardness. Dr Hartig followed up, asking whether the uncertainty is then likely to go down once new definitions are adopted. Dr Meneleo replied that this was likely because the variation due to interpretation should be removed, furthermore, once properly defined, edge point selections can be automated, perhaps improving the uncertainties further.

6.6. Report of the working group pressure and vacuum (CCM WGPV)

Ms Macdonald invited Dr Scherschligt (NIST), chair of the working group, to provide the report. The most recent working group meeting had been held online on 5 June 2025. It was attended by 35 individuals from 20 different NMIs representing

AFRIMETS, APMP, COOMET, EURAMET and SIM. It is expected that the WG will continue with regular online meetings but will try, when possible, to have in-person meetings. CMI (Czechia) has agreed to host one such in-person WG meeting in conjunction with the regular technical conference schedule, it will be held in Prague in 2029.

6.6.1. Main actions and achievements

Dr Scherschligt summarized the main activities of the working group since the last CCM meeting

- Completion of several guidance documents:
 - Guideline for reviewers of CMC entries in P&V, a risk-based approach. It assigns the evidence required to support a CMC depending on the risk associated with the CMC and its claimed uncertainty
 - Statement 2 on the content of CMC entries for pressure, vacuum, and molar flow rate, to guide users to the service they need based on the instrument they require calibrated
 - Statement 3, agreement on the uncertainties of the best units under test for CMC entries, these uncertainties are added to all CMCs depending on the device being calibrated. Some concern within the community about being required to add uncertainty, however this is added by all laboratories in the same amount
- Transition of new chairs to the WG, now Julia Scherschligt (vacuum) and vice chair Hiroaki Kajikawa (AIST/NMIJ) (pressure), taking over from Karl Jousten (PTB) and Jorge Torres (CENAM) respectively.
- Dynamic pressure – as it is fundamentally different technically compared to static pressure and is cross disciplinary, promotion of these activities to the CCM level has been proposed and is supported by the WGPV.

6.6.2. Progressing the state of the art

Dr Scherschligt presented a slide summarizing some of the main activities of the working group, which corresponded to traditional metrology including food safety, energy and health (e.g., eye tonometry). It is also leveraging advances from the redefinition of the SI and Quantum through activities in optical pressure realization and measuring vacuum pressure using cold atom traps. The group is also interested in quantum techniques for measurement at higher pressure, but the current state of the art using piston gauges is already meeting needs to the ppm level.

The working group in conjunction with ISO TC112 developed gas insensitive vacuum sensors based on a focused e-beam and operating between 10^{-2} Pa and 10^{-6} Pa with an uncertainty of 1 %. For higher pressure measurement, work continues in advancing piston gauge-based pressure metrology, with distortion characterization being an active area of research.

6.6.3. Liaison and stakeholders

WGPV maintains relationships with IMEKO TC16 (pressure and vacuum measurement), and ISO TC112 (vacuum technology). Stakeholders include:

- Accelerators and “big science” facilities such as gravity wave detectors
- Instrument manufacturers
- Semiconductor industry
- Automotive, aerospace, and energy
- Research institutes and academia.

6.6.4. CIPM MRA: KCs and CMCs

Key Comparisons include:

- CCM.P-K4 Atmospheric range, bilateral using new type of standard. A successful result will enable the use of a "quantum-SI" optical pressure standard as a laboratory standard.
- CCM.P-K3 high/ultra-high vacuum, desired by many NMIs, delayed start due to loss of a staff member at the pilot institute (PTB). Transfer standards are currently being characterized and will include the new type of ultra-stable ionization gauge developed by WGPV members in conjunction with ISO TC112.
- CCM-KC-ATL Leaks to atmosphere, change in protocol due to unavailability of refrigerant gas. Capillary-based approach. Several NMIs interested, including LNE (pilot), CMI, NMII and PTB.
- CCM.P-S1 Pneumatic pressure, measurements in progress, all should be completed by early 2026.
- Hydraulic pressure, many interested participants, no confirmed plan to date.

6.6.5. Programme of work for next two years

Dr Scherschligt presented the upcoming programme of work which includes replacing mercury manometers as primary realization with other alternatives including improved versions of well-established techniques (e.g. static expansion, pressure balances, oil-based manometers) or optical realizations based on refractive index. Particularly because of issues raised in draft B of a recent comparison, the group will begin to address how to account for dark uncertainty in key comparisons by considering adoption of “NIST decision tree” or other mechanism. In preparation for possible client demands, they will explore the use of digitalization schema developed by PTB, perhaps testing it during a comparison. Finally, the working group will continue development in areas related to food preservation, health, energy and other emerging needs.

6.6.6. Proposals

The working group recently voted to recommend working group membership for pressure and vacuum for RISE (Sweden) as they have high

quality and active areas of capability and research in static and dynamic pressure, with history of participation in comparisons and with published CMCs.

Ms Macdonald invited questions, however as there were none, she endorsed the proposal recommended by the WGPV to accept RISE (Sweden) as full member. The proposal was accepted with no objections.

6.7. Short presentation on the Realization Experiments for the Kilogram at PTB

Ms Macdonald noted a small change to the agenda before the break, providing Dr Thorsten Schrader (PTB) the opportunity to present results from recent measurements at the PTB on the realization of the kilogram. Dr Schrader introduced himself as a relatively new member of the community. He is the Head of the Mechanics and Acoustics Division at PTB, with previous technical and leadership positions in the Electricity and Magnetism field. Dr Schrader reported on the scientific effort put forth by PTB to investigate and reconcile differences in the realizations of the kilogram known through previous KCs (CCM.M-K8). These efforts included:

- Internal review of all steps for primary mass realization at PTB
- Cooperation between BIPM/PTB on the handling and cleaning of the Si sphere used as a transfer standard, investigation of observed mass differences
- Bilateral comparison (kilogram realization with Si Sphere) with NMJJ/PTB for volume and surface characterization, which confirmed agreement, Daniela Eppers, publication in preparation
- Cooperation with NIST and PTB to measure an Si sphere directly in the NIST Kibble balance to have multiple realizations in the same experiment.

Dr Schrader continued to summarize the XRCD method providing the equation for the mass of the polished, isotopically purified silicon single crystal sphere, which is dependent upon material parameters, surface layers (e.g. oxides and hydrocarbons), and the volume of the sphere. Previous comparisons included recalculation of material parameters, and constants and models for crystal impurities and defects. The PTB and NMJJ then compared volume and surface layer measurement.

At PTB, recent updates to the XRF spectral background model, resulted in an average increase of 13.5 μg for the mass of the surface layers. The new model and increased mass of the surface layer also slightly impact the optical phase shift during core volume measurement, this effect is well within the previous uncertainty and has been included in the new realization value for the 2024 results. The uncertainty has been reduced slightly and a paper for Metrologia is in preparation.

For the bilateral comparison with NMJJ, measurements of the surface layers and volume on an unknown silicon sphere was performed. Both the core volume and surface layer results were found to agree very well.

Dr Schrader commented that within the Si trust programme at PTB, many natural silicon spheres were distributed to other NMIs and even though many returned with signs of wear including scratches, their masses were nearly the same, demonstrating good stability due to the hardness of silicon.

Ms Macdonald invited questions on the presentation. Mr Massa (INRIM) asked, considering the clear agreement in the surface layer mass and the volume of the sphere between PTB and NMII, are their respective realization values now in better agreement? Dr Schrader replied that demonstration or not of improvement will be shown in the draft A report which will be distributed shortly. The lattice parameter will need to be measured again. Mr Massa followed up by noting that since there is only one measurement of the lattice spacing (performed at INRIM) and this is a common value between PTB and NMII, if there continues to be a difference it is likely in another part of the experiment. Dr Schrader replied with his agreement.

Dr Milton asked whether the difference in volume presented between PTB and NMII for their bilateral was effectively equivalent to about 1 μg . Conferring with Dr Eppers it was estimated that the difference is equivalent to less than 8 μg . Dr Kuramoto (NMII) agreed and confirmed that the mass equivalent difference is small, around a few micrograms. (During the note writing the secretary confirmed the calculation to be approximately 5 μg , based on the volume values reported in the presentation). Dr Milton asked what silicon material was used to measure the lattice spacing; enriched or natural? Dr Schrader confirmed the measurements were performed on enriched Si. Mr Massa followed up mentioning, for information purposes, that INRIM and PTB had a new collaboration to re-measure the lattice spacing of enriched Si at PTB using a new experimental setup.

7. Combined report of the CCM Working Group on Mass (CCM-WGM) and from the Task Group on the Phases for the Dissemination of the kilogram following redefinition (CCM-TGPfD-kg)

Ms Macdonald noted that the two reports from the WGM and TGPfD-kg would be combined into a single presentation and invited Dr Davidson, (NPL) the TG and WG chair to provide the merged report. Dr Davidson presented the list of meetings which included a WG meeting held on 24 June 2025 (hybrid) and 30 April 2024 (online) and meetings of the task group held online in July 2023, July 2024, April 2025, and hybrid in June 2025.

7.1. Report of CCM-TGPfD-kg

For the Task group the members were shown, noting that they represent a balance of RMOs with and without experiments. All members are happy to continue, and more members will be recruited in the future, particularly from NMIs that do not have realization experiments.

The Terms of Reference for the task group were shown and noted to generally be the same going forward with some changes expected to prepare for the final phase of dissemination from individual realizations. Current terms of reference can be found on the BIPM TG website. Presently the terms of reference are:

The dissemination of the kilogram after 20 May 2019 is taking place in three consecutive phases:

- 1. Traceability to the IPK (taking into account the additional uncertainty from the new definition) (May 2019 to February 2021),*
- 2. Dissemination of the consensus value (from February 2021),*
- 3. Dissemination of individual realizations (in the future).*

Based on "the mise en pratique of the definition of the kilogram" and on "the CCM short note on the dissemination process after the proposed redefinition of the kilogram" the task group will:

- Ensure the correct implementation of the present traceability across the period of the redefinition of the kilogram, a detailed calculation of the consensus value and its uncertainty and oversee the transition for the "present traceability" to the use of the consensus value,*
- Propose methods to maintain the best possible stability of the consensus value over time (including comparison periodicity),*
- Propose clear criteria for moving from the consensus value dissemination phase to the individual realization dissemination phase,*
- Maintain a detailed document describing the three dissemination phases for the CCM and the mass community. This document includes the calculation of the consensus value, its uncertainty and time scale as well as any other relevant information related to the dissemination of the kilogram,*
- Provide advice to the CCM-WGM in all questions regarding traceability of the kilogram during the first two phases above.*

At the time of the presentation, the mass system is in Phase 2, with the latest adjustment of the Consensus Value calculated and in effect February 2021. Dr Davidson noted that it seems increasingly likely that we will move to Phase 3 of the dissemination of the kilogram, and this will be discussed further in upcoming talks later in the day.

Dr Davidson recalled the 2023 CCM recommendation on improving agreement in the realization experiments, which is key to transitioning to Phase 3. The recommendation encourages NMIs to continue research and development on realization experiments, and requests targeted investigations into lack of agreement with existing experiments. It recommends the TG outline a structured approach for this activity. Dr Davidson summarized the key points and showed the roadmap produced by the TG which indicated planned inter-comparisons between labs, and development work ongoing at individual laboratories and their associations with others. The CCM.M-K8-2024 key comparison of realizations was described, and it was noted to be nearly complete with some final stability checks ongoing. The previous two iterations of the comparison in 2019 and 2021 were reviewed and the discrepancy between NRC and PTB highlighted as a barrier to moving to Phase 3. Disseminating from either of those results individually could result in slightly different value of the kilogram.

During the most recent TG meeting earlier in the week, preliminary results of the CCM.M-K8 comparison were presented. They indicated a significant improvement in the agreement between previously discrepant measurements. The next comparison

was agreed to be run in 2027 and if the results continue to show agreement, it is considered likely we will be able to move to Phase 3. The initial and ongoing assessment for the next Consensus Value of the kilogram Adjustment is likely to result in an additional change of $-5\ \mu\text{g}$, bringing the total change since redefinition to $-12\ \mu\text{g}$. Dr Davidson reminded participants that this is due to the elimination of the 2016 pilot comparison from the running average of the three most recent comparisons. While it is too early to confirm, this is likely to be the last change before moving to Phase 3. Finally, during the meeting, the Guide to the Consensus Value of the kilogram was discussed and the proposed version distributed to WGM members. It has been approved and will be published on the BIPM website in the TGPfD-kg area soon after the meeting.

Dr Davidson showed the criteria for moving to Phase 3 as outlined in the CCM detailed note on the dissemination process after redefinition of the kilogram also in the TGPfD-kg area of the BIPM website. He noted that if the recent KC results are maintained, and agreement continues after the next iteration of the ongoing KC, all criteria will be satisfied to move to Phase 3. The next steps of the TG will be to clarify how this will be implemented, particularly considering some options for dissemination; Including from “validated” experiments at the level of their individual uncertainties or disseminating from an “international mean kilogram” using results from the ongoing KC, and at what level of uncertainty. Furthermore, how will realizations by end users be validated: are existing methods sufficient?

Dr Davidson moved on to the report of the working group on mass.

7.2. Main actions and achievements WGM

The main actions and achievements include some items discussed within the TG portion. These include the CCM recommendation on addressing lack of agreement in realization experiments, the roadmap targeting this work, key comparison measurements for the realization experiments with preliminary results demonstrating improvement in agreement, and completion of various guides including to the CV-kg guide and submission of CMCs. Additionally, progress was made on the coordination of digitalization projects, particularly digital calibration certificates.

7.3. Progressing the state-of-the-art WGM

Members of the working group continue to develop realization experiments, with new experiments coming on-line and both improving uncertainties and agreement between experiments. Application areas of the Kibble balance principle are being extended to tabletop versions, micro-Kibble balances, torque realization and EM radiation force balances.

Progress in the area of digitalization has been made, in which completion of a virtual comparison in mass (single 1 kg) using the Digital Calibration Certificate (DCC schema), this involved ten Participants, and the results have been published in Measurement: Sensors. A more complex virtual comparison with additional complexity demonstrating increased functionality will be pursued. Among other features this could for example automatically compare results to CMC entries to confirm they are validated. Additional work is being pursued (led by PTB) on the interoperability of

DCCs, and there is a cross-RMO collaboration that includes end users. Also mentioned is the BIPM forum on Digital Metrology (FORUM-MD) which contains a WG that coordinates between CCs and for which the WGM is represented by Dr Davidson.

7.4. Liaison and stakeholders WGM

The WGM liaises with IMEKO TC3, OIML and weight and balance manufacturers. The end user base is quite wide and includes those stakeholders that come to NMIs as they require very low uncertainties such as: pharma industries and calibration labs, trade, and the scientific/academic communities, and those in fields of derived quantities that rely on mass. Plans to improve liaisons will include webinars in special areas of interest and training, interim WG meeting will be set online or in conjunction with associated meetings (e.g. Kibble Balance technical meeting). More regular meetings with RMO TC chairs to improve coordination of KCs and SCs and disseminate information.

7.5. CMCs and Programme of work

Dr Davidson summarized in a table the past and planned comparisons from K1-K8 covering the mass range 1 mg – 50 kg. CCM.M-K2, which includes multiples and submultiples of the kilogram in stainless steel was last run in 1999 and is planned to be completed the end of 2027, and CCM.M-K4 (1 kg stainless steel) last run in 2023 will be run in 2026 in a similar fashion to M-K8 in which NMIs send their own kilogram artefacts to the BIPM for intercomparison. A repeat of CCM.M-K8 (realization of the kilogram) will be run in 2027 and is planned to be repeated every 3–4 years.

7.6. Proposals

Dr Davidson presented proposals that had been recommended by the WGM or TGPfD-kg, these include the continuation of Stuart Davidson as chair of both the WG and the TG, and Richard Green as Vice-Chair of the WG. It is further recommended to seek and add new members to the TG and accept membership of KEBS (Kenya) and NIMT (Thailand) to the WGM. They each provided interesting presentations during the WGM meeting, with KEBS highlighting significant outreach and training, and research support for weight manufacturers. Dr Davidson commented on the importance of having more members from the AFRIMETS RMO on the WG. NIMT had also presented their work, remarking on their participation in a large number of comparisons, and development work on a Kibble Balance. Dr Davidson noted the working group members were all happy to accept both their memberships. In closing he recommended the acceptance of two new KCs CCM.M-K4.2026 and CCM.M-K8.2027 and noted that the two Pilot studies on determination of Centre of Gravity and Measurement of magnetic susceptibility of mass standards do not need to be approved by the CCM but are mentioned for completeness.

Ms Macdonald opened the floor for questions. Mr Massa (INRIM) commented that for the XRCd method for the realization of the kilogram, not only should the volume and surface layers be characterized, but also parameters related to the internal structure such as impurities and lattice spacing. These should not necessarily be considered as a constant but should be re-evaluated. Dr Davidson replied that he completely agrees, particularly the unique lattice spacing measurement represents a

potential single point of failure as it is relied upon for all XRCd realizations. Mr Massa followed up commenting that if anyone is interested in the lattice spacing measurement, INRIM is open for collaboration on this topic.

Mr Abrantes (IPQ) asked from the perspective of small NMIs, what realization activities should be pursued? Dr Davidson replied that the trajectory of development for Kibble Balances sees them becoming simpler, at least mechanically, and collaborations with NMIs developing these simplified versions should be encouraged. From a dissemination perspective, the TG is considering options for how the route from independent realization experiments to the global mass scale should look and options for this route will be developed further within the TG.

Ms Macdonald read a question from the online chat, which asked is there an estimated timeline for moving into Phase 3? Dr Davidson replied that he didn't want to comment precisely but directed participants to look at the criteria for moving to Phase 3 and listen to Dr Stock's (BIPM) upcoming presentation to draw a conclusion for such a timeline.

Dr Milton enquired in reference to the requirements to move from Phase 2 to 3:

aiii) Demonstrate stability by producing consistent (equivalent) results for two consecutive Key Comparisons.

And

d) The difference between the Consensus Value for the kilogram (determined from the last three Key Comparison results) and the KCRV for the final Key comparison is less than 5 parts in 10^9 .

He regarded it likely that at least one more key comparison would be required. Dr Davidson agreed and commented that if values remained consistent for the next key comparison then it is likely that all requirements would then be met.

An online question was asked, read by Ms Macdonald, whether the KCs would include or comment on *how far the light shines* (i.e. what calibration capability do the KCs support)? Dr Davidson replied that this will be included in the KC protocols.

Ms Macdonald highlighted proposals from the WG that required approval, these were for the new WG members and the two new KCs. All proposals were approved without objection. Ms Macdonald congratulated the new members of the WGM.

8. Work Programme of the BIPM mass laboratories

Ms Macdonald invited Dr Stock to present the talk. He commenced by summarizing the staff of the Physical Metrology Department that he heads, which is comprised of Electricity and Mass, the mass section has four members: three working on the Kibble Balance, and one responsible for mass calibrations.

The work programme of the BIPM mass laboratory involves providing mass calibrations to NMIs of Member States, organizing KCs, development and maintenance of "the international Kibble balance", provision of Pt-Ir prototypes, and internal calibrations of pressure gauges for the BIPM. The work includes the maintenance of a stable mass unit through a three-tiered hierarchical system of many Pt-Ir standards that are linked to the IPK 2014, and from which offsets are applied depending on the

CV-kg for external calibrations. Recalibrations of the standards occur from the highest tier every 5 years (every year from tier 2) and in 2024 they showed standards in the 2nd and 3rd tier had a mass overestimation of 3 μg , well within the 5 μg (2nd tier) uncertainty of the masses. The drift due to contamination of the standards is now estimated to be 1 $\mu\text{g}/\text{year}$, reduced from 1.5 $\mu\text{g}/\text{year}$ over the previous five years.

Dr Stock summarized the results of the past two iterations of the CCM.M-K8 comparisons of realization experiments in the form of a graph, highlighting the most significant feature, the discrepancy between NRC and PTB. While the comparisons of 2019 and 2021 had seven and nine participants, the 2024 iteration had ten. He summarized the present status of the 2024 KC and its protocol in more detail noting at the time of the presentation seven of ten reports had been received. In total six Kibble Balances, 1 Joule balance and, three XRCD experiments participated. They did so by calibrating two of their own masses (travelling standards) traceably to their realization experiment and then shipped them to the BIPM for intercomparison and measurement against the BIPM as-maintained unit, which is physically stable. When returned, the travelling standards were checked for their stability. The stability results showed that most standards were stable to within $\pm 5 \mu\text{g}$ and with one at $-15 \mu\text{g}$. The preliminary and anonymized results were shown for the comparison, demonstrating that all comparison results now agree, and the inconsistency seems to be resolved.

Moving to the calibration service of the BIPM Dr Stock summarized the historical calibration trends from 2000-2024, in average six Pt-Ir and 12 stainless steel standards are calibrated per year and sometimes can include determination of density and centre of mass. The BIPM has served 91 % of Member States through calibrations and comparisons, from 2015 to 2024, and through provision of Pt-Ir standards. Calibration services had undergone an external audit (peer review) in 2024 without any major non-conformity. Largely due to cost increases of the Pt-Ir alloy, and transition to the new definition of the kilogram, it has been decided that the BIPM will no longer provide Pt-Ir standards. Forty-five countries already have a such standards with some having up to eight.

Several improvements have been made to the BIPM Kibble balance since 2023 including S/N ratio in velocity phase, vertical alignment of interferometer beams, measurement of absolute gravity by quantum gravimeter (AQG) and grounding improvements. The uncertainty of the realization measurement is about 36 μg , dominated by 27 μg in alignment uncertainty due to parasitic coil rotations. The recent gravity measurements using the AQG agree with historical measurements (2009, 2019) using an FG5 (METAS). Advances have also been made in the single pan compact Kibble balance largely related to reduction/compensation of parasitic motions during the velocity phase.

Moving forward the BIPM will continue work on both Kibble balances, and the work described, repeating the comparison of realization experiments every 3 years or so and the comparison of secondary masses (1 kg) every ten years. Additionally, development of DCCs and training in realization and dissemination of the kilogram will be pursued.

Closing the presentation, Dr Stock posed two questions for consideration; how best to pursue knowledge transfer given the small number of staff, and what should be the basis for dissemination of the kilogram unit from the BIPM in Phase 3. For example, from independent realizations with their corresponding uncertainty, or from an *international mean kilogram* based on the ongoing KC results using an *ad hoc* uncertainty (e.g. $u=20\text{ }\mu\text{g}$) or similarly using an *international mean kilogram* using weighted mean/uncertainty calculated from the ongoing key comparisons ($u \ll 10\text{ }\mu\text{g}$).

Ms Macdonald opened the floor for questions or comments. Dr Chen (CMS/ITRI) thanked the group for allowing CMS/ITRI to participate in the key comparison and for the BIPM for piloting it, commenting that they look forward to participating again in the future. Dr Stock noted, that as an associate member in principle CMS/ITRI should strictly not be allowed to participate but has been given permission based on the scientific value associated with having the largest view of realization experiments.

9. Presentation in support of application for Observership from INM Colombia

Ms Macdonald invited Mr Escobar Soto to present (on-line) in support of Instituto Nacional de Metrología of Colombia (INM) application for Observership in the CCM. In this presentation he reported on activities and capabilities in mass and related areas at INM. The institute was founded in 2011 in Bogotá and has participated in the CIPM MRA since 2013. The institute is responsible for providing calibration services, metrology assistance and training, proficiency testing and the production of reference materials. The mass and related quantities laboratories lie within the physical metrology sub-division and touch all areas covered by CCM working groups, with some planned activities in gravimetry. INM holds six CMCs in mass (1 mg to 1000 kg) traceable through Pt-Ir national standard 108 and the BIPM, eight in pressure and vacuum (0.1 Pa to 500 MPa), three in force (0.1 kN to 1 MN) and torque (2 N m to 3 kN m), and one in density and viscosity. Other technical services include volume and gas flow calibration. These are supported by several comparisons in each area.

INM has several external research projects completed or pending. These include several European projects including in mass, torque, pressure for green hydrogen, and gravimetry. Internal projects have improved or added capability in mass, hardness and volume. New capability in surface tension of liquids is being pursued.

Mr Escobar Soto presented several other noteworthy activities of INM scientists such as acting as peer reviewers, trainers, and SIM working group chairs. Additionally, SIM awards and memberships on technical committees.

After the presentation was completed Ms Macdonald requested questions or comments from the audience. Dr Scherschligt commented in support of INM's application noting NIST has hosted several technically gifted guest scientists in their vacuum and pressure laboratories and that INM was an exceptional host and organizer of the 2017 vacuum and pressure conference. She considers that their Observership to the CCM would be a strong asset for the community.

Ms Macdonald remarked that a decision on Observership to the CCM would be made formally by the CIPM, through a recommendation from the CCM president, and she would take care of the necessary steps.

Ms Macdonald adjourned the meeting for the day, to reconvene 9:00 am (Paris time) the following morning.

10. Updates from JCRB and KCDB

Ms Macdonald reconvened the meeting for the day and introduced Dr Yamazawa, the JCRB Executive Secretary to provide the first part of the presentation.

10.1. Update from JCRB

Dr Yamazawa began, commenting in general that the CIPM MRA in general is working well, particularly under the CCM, with some issues to address and improve. The 47th and 48th meetings of the JCRB were held in September 2023 and 2024, at LACOMET (Costa Rica) and BIPM respectively. Improvement on guidance materials related to the use of columns for KCDB CMC listings, RMO reactions to JCRB reviews, review extensions with non-response from RMOs, and the review of comparisons that are taking longer than expected (>5 years). The actions from the meeting were presented briefly and it was noted that they could all be reviewed in the working documents sections for the meetings.

Dr Yamazawa presented a flow diagram for submission, review, and publishing of CMCs, these are available in the “KCDB getting started” documents in the BIPM website. He continued presenting present statistics from the KCDB; for the CCM, the number of new CMCs approved has been varying but generally decreasing per year with 147 in 2021, and 48 in 2024 and 21 in 2025 so far. Total number of CMCs in the KCDB is 26 165, of which 2 985 are under the CCM making about 11.4 %. Since the introduction of the KCDB 2.0, each CMC may contain multiple capabilities since uncertainty tables or ranges can be included, so trends are less relevant. Presently there are 39 CMCs under review, and another 33 under revision by the writer. There are a few “hanging CMCs” which are under revision by the writer but have not progressed for over six months. Some instances of missing opportunities (loss of rights) for review were presented in a table indicating statistics from all RMOs, and the reason for it. Most are due to non-responses or accepting review but not completing them. Dr Yamazawa summarized the main potential issues within the CCM as being hanging CMCs (30 total), CMCs slipping through review, and comparisons over 5 years old. A 3-week extension in RMO review of CMCs has been added to the KCDB, which will be automatically applied if no RMO has responded regarding an intention to review after an initial three weeks. A review of comparisons that are over 5 years old has been requested and the CCs are to report the JCRB (49th meeting) the cause of the delays and actions that will be taken to address them. There are presently five outstanding comparisons within the CCM: one density, two in force, one in fluid flow, and one in pressure. The deadline to provide the requested information is 28 July. The same information is being requested for RMO comparisons. Dr Yamazawa closed by

thanking the audience, highlighting that he is now the 12th JCRB Executive Secretary and he is looking forward to serving in that capacity.

10.2. Update from KCDB

Dr Maniguet, the KCDB coordinator, provided the update to CCM. Since 2021 there have been yearly training sessions through online webinars and technical exchanges. These are available through the Capacity Building and Knowledge Transfer (CBKT) area of the BIPM website and potential participants are invited through the RMOs.

Dr Maniguet commented that the KCDB software was updated in 2024, and these updates are the focus of her presentation. CMC identifiers had only been available to reviewers but are now viewable and available externally (searchable) and can be used to link into the SI digital framework. The search tool was also updated to allow wild card (*), as well as AND, OR conditional searches, which are useful in generating statistics. The module for CMC statistics was also improved and now includes items such as total number of CMCs received for review, number reviewed, and total loss of rights. Updates will be added to improve communication options between reviewer and writer during the JCRB review process, for example a reviewer can notify a writer of a short question or comment, and document uploads will be allowed to support such interaction. Facilitated and timely interaction could expedite reviews. Work to expand the use of control menus into the CMC submission form is being pursued to direct users and reduce the variety of inputs in support of digitalization. Consultation will begin in 2025 to determine the requirements of each CC. Updates to the KCDB APIs have been made and are ongoing to integrate FAIR principles. The next steps will be to determine how to integrate the SI reference point into the KCDB, and to expand the KCDB API for machine-readable comparison data. Since comparison reports will no longer be published in *Metrologia* from January 2026, work has/will be performed to implement a new service ensuring comparison reports are citable with assigned DOIs.

Dr Milton made a comment related to the APIs. They are being visited broadly by the large language models (LLMs), and are being used for AI training. The data provided by the APIs should be formatted in such a way that the influential search engines and LLMs can interpret it and provide the right information when queried, for example about CMCs. Work is being done to benchmark accuracy of the information that is gained through this route.

Dr Fraser (NIST) asked whether moving the comparison reports from *Metrologia*, to the BIPM website is likely to reduce the accessibility or the quality of the report. Dr Milton replied that the quality should remain the same since it is just the publishing step that has moved, and a DOI with landing page that was assigned by *Metrologia* will now be assigned by the BIPM so accessibility should be at least equivalent.

11. Reports from RMOs

Ms Macdonald invited the presentation of reports from the RMOs.

11.1. Report from AFRIMETS

Dr Mautjana was invited to provide the report for AFRIMETS. There are about 54 countries in the region with four members and nine associate members of the CGPM. The structure is like that of the CCM with the same working groups save gravimetry. Hardness is included in the Force and Torque WG. Recent meetings include yearly RMO meetings typically in July or August. These were held in Egypt in 2023, and Kenya in 2024, with one planned in July 2025 in Ghana. In addition, a regional conference is held yearly, it is coordinated by Kenya and hosted in the eastern part of the continent. A training session on uncertainty in measurement was sponsored by PTB and held in Johannesburg in February 2025; 14 Member States participated.

There are seven key comparisons ongoing, including five regional and two key comparisons. Two comparisons are at the stage for draft A development. Nine comparisons have been completed since 2020 with four since 2023 supporting the publication of 23 CMCs across four NMIs (NIS, EMI, KEBS, NMISA). CMCs from two additional countries are under review (TBS, BOBS).

Regarding RMO strategy, there is intention to introduce a membership fee to support technical activities, such as for artefacts and their transportation, and for travel of participants to meetings. AFRIMETS will seek to harmonize regional regulations and standards, particularly related to transport restrictions and their impact on moving artefacts throughout the region. They will further seek to enhance collaboration with all RMOs and other strategic partners.

11.2. Report from APMP

Dr Ogushi presented the report of APMP TCM of which he is chair. Within TCM there are two working groups: Mass and Density, and Pressure and Vacuum, representing all quantities in the CCM. The TC membership included 32 organizations representing 31 economies. The last meeting was hosted by NPLI in November 2024. TC projects include training in absolute and relative gravimetry, and a CMC task force which is supporting the establishment of mass CMCs in developing countries in the region. There have been 12 regional comparisons since 2003 that are not yet complete, two of which have been abandoned, two at draft A, and two approved for equivalence. Six hybrid comparisons have been planned or ongoing since 2024. There have been over 60 inter- and intra-RMO CMC reviews across all technical areas. Other activities include the pursuit of digitalization with some NMIs already starting to issue digital certificates to their domestic clients, and the exploratory planning of new regional comparisons, for example 50 kg mass, and pressure, as well as a workshop on dynamic pressure hosted by Dr Pitakarnnop (NIMT) during the last general assembly in 2024.

11.3. Report from COOMET

Dr Shmigelskiy presented the report from COOMET TC 1.6, which includes 14 Member States with eight activity fields spanning the Mass and Related Quantities area. There are 131 CMCs in the region spanning all CCM WG areas except gravimetry. These CMCs are held by six countries and seven institutes. Meetings of TC 1.6 in 2023 and 2024 have been attended by most Member States, with 13 attending the last meeting held in 2024. The next meeting will be held on 1-2 October in Bishkek. Fifteen comparisons are planned or are in progress, with five at the draft A stage. In support of youth

engagement in metrology COOMET coordinates a “We are the future conference” approximately yearly, in which best young metrologist competition is held. In 2024 there were over 350 participants and 160 reports, the next one is planned for 2026 in Saint Petersburg.

11.4. Report from EURAMET

Mr Wozniak presented the report of EURAMET TCM for which he recently became the chair in June 2025. Within TCM there are six subcommittees matching the WGs of the CCM as well as three working groups corresponding to Strategy, Digitalization, and Dynamic measurements. There are chairs and vice chairs for each of these working groups and chairs for each subcommittee. TCM meetings were held in 2023 in Brussels and 2024 in Turin, they included meetings of subcommittees and WGs as well as for various related EMPIR/EPM collaborative research projects. There have been seven completed EMPIR R&D projects since 2023, with four ongoing. Two calibration guides (pressure balances, and automated catch weighing instruments) have been updated, with eight guides to be newly published or revised. A EURAMET training course in mass was hosted by RISE in 2023 with input from NPL, a Mentorship in 2024 for NSAI (Ireland) in pressure was hosted by RISE and workshop on dynamic measurement is planned for spring 2026 also hosted by RISE.

Four Pilot studies or hybrid comparisons are ongoing (one has been completed) in mass scale realization, high vacuum pressure, dynamic pressure, and viscosity. Five regional key or supplementary comparisons have been completed, with fourteen ongoing. As of 22 June 2025, TC-M and TC-Flow members represent 1 436 CMCs, with 71 approved since 2023. Some issues to consider within the TC are the harmonization of CMC entries.

Other activities are being pursued for example within the Digitalization WG, including DCCs for mass and other areas such as force, torque, volume and the use of digital metrology experts (DME) to automate end-to-end comparisons. The Strategy WG supports the coordination of various European metrology project proposals and partnerships, seeks to improve engagement with stakeholders, promotes knowledge transfer and coordinates the production of calibration guides and roadmaps.

11.5. Report from SIM

Ms Preste (LATU) chair of SIM TC-M (MWG7) presented on behalf of the SIM RMO. SIM has been a legal entity since 2016 and is comprised of five sub-regions: North America (NORAMET), the Caribbean (CARIMET), Central America (CAMET), the Andes region of south America (ANDIMET), and south and eastern part of South America (SURAMET). All regions combined made up a total of thirty-three countries. The SIM working group Mass is Metrology Working Group 7 (MWG 7) within the organization of SIM’s 14 Working groups comprising all areas of metrology. SIM MWG 7 is further divided into seven sub-committees (SC) along the same WG divisions as the CCM, with gravimetry sub-committee planned to be formed. All SCs have their own chair. MWG 7 meetings generally occur yearly with recent meetings in May 2024 and 2025 in Costa Rica and Colombia respectively. Additionally, there has been a Viscosity meeting at

CENAM (Mexico) in 2024 and a training meeting in Force and Torque in 2023 hosted by IDIC (Chile). The next meeting is planned for August 2025 at INM Colombia.

NIST has supported several SIM technical training activities such as the SIM Internship programme, and the SIM school hosted by INM and which took place in 2024. It had over 70 students.

In mass there have been four KCs with two approved for equivalence and two either in the draft A or draft B phase. The KCs combined cover the range 200 mg to 50 kg in stainless steel including at 1 kg. There are also four ongoing supplementary comparisons in mass, with one near publication of the final report. There are also ongoing KCs or SCs in Viscosity (1), Pressure and Vacuum (2), Force and Torque (10) for which the measurements are completed or in the report drafting phase for most comparisons.

There have been four calibration guideline documents published or translated by SIM, with the most recent ones on the calibration of non-automatic weighing instruments.

Plans within SIM include convening of meetings in 2025, 2026 hosted by CENAMEP Panama, one on Force and Torque, and a training in Pressure and Vacuum. Additionally, training or workshops in hydrometer calibration and Density and Viscosity are planned for 2026-2027, along with the formation of sub-committees in Gravimetry and Viscosity around the same time frame. Finally, several comparisons are planned in mass and a pilot study in surface tension.

Ms Macdonald requested questions or comments regarding any presentation, and Dr Fraser asked regarding the EURAMET presentation, how much interest are they finding on a dynamic measurement group? Mr Wozniak replied that the group has not yet been established, but they are expecting at least ten members with active participation from the area of vibration.

12. Decisions and Actions of the CCM

Ms Macdonald noted that most actions and decisions required were addressed as the meeting progressed but that she would present and summarize the approved items.

12.1. Decisions

The summary of all proposals was presented as follows:

CCM-WGDV

- Chair: Dr Daniela Eppers (PTB), Vice-Chair: Dr Zhang Zhengdong (NIM)
- new KC: CCM.D-K6 (Refractive Index of liquids); pilot study on viscosity measurements of non-newtonian liquids in discussion
- new members: KEBS (Kenya), NMIT (Thailand) and NMIM (Malaysia).

CCM-WGG

- new members: PTB (Germany); Dr Hartmut Wziontek (BKG, Germany) as personal expert.

CCM-WGM

- new KCs: CCM.M-K4.2026 Stainless Steel kilograms

CCM.M-K8.2027 Realization experiments

Pilot Study - determination of Centre of Gravity

Pilot Study - Measurement of magnetic susceptibility of mass standards

- new members: KEBS (Kenya) and NMIT (Thailand).

CCM-WGPV

- new member: RISE (Sweden).

Ms Macdonald summarized the decisions in which the WGDV Chair and Vice-Chair were appointed based on the WG proposal, and all new KCs as proposed by the WGs were approved as well as all new WG members as proposed by the WGs.

12.2. Actions of the CCM

Ms Macdonald summarized actions to be taken by the CCM:

1. WGFF and WGPV: shift the CMC entries for molar flow back to WGPV
2. Launch TG on Dynamic Measurements
3. The TGPfD-kg will manage the calculation of the next Consensus Value and establish a detailed strategy for advancing towards Phase 3 of the kilogram dissemination process
4. The CCM president will make a recommendation to the CIPM on the acceptance of one CCM Observership application – INM (Colombia).

13. Next meeting and any other business

Ms Macdonald reported that the 21st CCM meeting would be convened at the BIPM headquarters in May or June 2027, the exact date would be communicated at a later date. She gave an opportunity to participants to discuss any other business, and as there was none requested, she adjourned the 20th meeting of the CCM. The planned technical *Workshop: Session II on Key Comparisons and Digitalization* would take place after the break.



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