

Bureau International des Poids et Mesures

Consultative Committee for Thermometry (CCT)

Minutes of the 29th meeting
Session 1
20 October 2020

Due to the present pandemic, the 29th meeting of the CCT is held on-line.
It is split into five sessions spanning over October 2020 until February 2021.

These minutes will be incorporated at a later stage into the CCT's Report to the CIPM.

LIST OF MEMBERS OF THE CONSULTATIVE COMMITTEE FOR THERMOMETRY

as of 20 October 2020

President

Y. Duan, member of the International Committee for Weights and Measures

Executive Secretary

S. Picard, International Bureau of Weights and Measures [BIPM], Sèvres

Members

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

All-Russian Scientific Research Institute of Physico-Technical Measurements, Rosstandart [VNIIFTRI], Moscow.

Centro Español de Metrología [CEM], Madrid.

Centro Nacional de Metrología [CENAM], Querétaro.

Conservatoire National des Arts et Métiers/Institut National de Métrologie [LNE-Cnam], La Plaine-Saint Denis.

Czech Metrology Institute [CMI], Brno.

D.I. Mendeleev Institute of Metrology, Rosstandart [VNIIM], St Petersburg.

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

Instituto Português da Qualidade [IPQ], Caparica.

Istituto Nazionale di Ricerca Metrologica [INRIM], Turin.

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

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

National Institute of Metrology [NIM], Beijing.

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

National Measurement Institute of 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 [UME], Gebze-Kocaeli.

National Physical Laboratory [NPL], Teddington.

National Research Council of Canada [NRC], Ottawa.

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig.

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

VSL B.V. [VSL], Delft.

VTT Technical Research Centre of Finland Ltd, Centre for Metrology / Mittatekniikan keskus
[MIKES], Espoo

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

Official Observer(s)

FSB - Laboratory for Process Measurements [DZM/FSB-LPM], Zagreb.

1 **OPENING OF THE MEETING; APPOINTMENT OF THE RAPPORTEUR; APPROVAL OF THE AGENDA**

The twenty-ninth meeting of the Consultative Committee for Thermometry (CCT) was held in five separate sessions via the web due to the pandemic crisis.

The following participants were present at the first session:

Z. Ahmed (NIST), I. AlFaleh (SASO-NMCC), M. Anagnostou (EMI), S. Bell (NPL), J. Bojkovski (MIRS/UL-FE/LMK), J.D. Brionizio (INMETRO), C. de Bruin (VSL), D. del Campo (CEM), B. Choi (KRISS), Y. Duan (NIM), E. Ejigu (NMISA), L. Eusebio (IPQ), R. Feistel (IAPWS), X. Feng (NIM), V. Fericola (INRIM), S. Fil (NSC "Institute of Metrology"), J.-R. Filtz (LNE), C. Gaiser (PTB), R. Gavioso (INRIM), B. Hay (LNE), M. Heinonen (MIKES), F. Jahan (NMIA), M. Kalemci (UME), K. Quelhas (INMETRO), L. Knazovicka (CMI), L. Eusebio (IPQ), L. Lira Cortes (CENAM), G. Machin (NPL), N. Maphaha (NMISA), A. Merlone (INRIM), M. Milton (BIPM), R. Mnguni (NMISA), T. Nakano (NMIJ AIST), H. Nasibli (UME), J. Pearce (NPL), A. Peruzzi (NRC), S. Picard (BIPM), A. Pokhodun (VNIIM), P. Rourke (NRC), S. Rudtsch (PTB), M. Sadli (LNE/Cnam), N. Sasajima (NMIJ AIST), P. Saunders (MSL), Y. Shaochun (NMC, A*STAR), G. Snijders (VSL), F. Sparasci (LNE/Cnam), R. Strnad (CMI), W. Tew (NIST), A. Todd (NRC), C.M. Tsui (SCL), E. van der Ham (NMIA), L. Wang (NMC, A*STAR), N. Yamada (NMIJ AIST), I. Yang (KRISS), H. Yoon (NIST), Z. Yuan (NIM), J. Zhang (NIM), D. Zvizdic (FSB).

Also present: S. Picard (Executive Secretary of the CCT)

The President of the CCT, Dr Y. Duan opened the meeting and welcomed the participants.

Dr Y. Duan recalled that the 29th meeting of the CCT, scheduled to be held at the BIPM in March 2020, was cancelled due to the pandemic crisis. The 29th meeting of the CCT is therefore held remotely via internet¹, split into five two-hour sessions spanning from 20 October 2020 until 19 February 2021. Dr. Y. Duan indicated that the International Committee for Weights and Measures (CIPM) had approved the amended version of the CIPM D-01 document ([Rules of procedure for the Consultative Committees created by the CIPM, CC Working Groups and CC Workshops](#)) that now includes the possibility to hold on-line sessions. He also informed that the next session will be held at 12:00 UTC instead of 11:00 UTC.

Dr. Y. Duan made a call of the nominated delegates. Dr S. Rudtsch (PTB) was appointed *rappporteur* for the first session.

The Director of the BIPM, Dr Martin J.T. Milton, welcomed the participants.

The agenda of the meeting was approved with no changes or additions [CCT/20-01].

¹ Cisco webex

2 REPORT OF THE 28TH MEETING OF THE CCT 2014

The Executive Secretary of the CCT, Dr S. Picard, recalled that the report of the 28th meeting of the CCT (2017) had been approved by all delegates by e-mail. The status of the actions which arose from the 28th meeting (see [CCT/SUMM-2017](#)) was as follows:

Actions of 2017

CCT28/A1. T. Herman (NIST) will send CCT-K9 Draft B to participants by October 2017.

Status: Not completed

CCT28/A2. B. Fellmuth (PTB) will address the final version of the Mise en Pratique to the CCU for their September 2017 meeting, and appendices by December 2017.

Status: Completed

CCT28/A3. WG-SP shall provide the first revision of the CCT Strategic Planning document by Dec-2017 (coordinated by J. Fischer (PTB)).

Status: Completed

CCT28/A4. WG-KC will update the CCT President on silent comparisons and plans for their completion by October 2017.

Status: Completed

CCT28/A5. J. Fischer (PTB) will draft a statement to clarify the relationship between the ITS-90 and the kelvin that will be posted on the BIPM web.

Status: Completed

CCT28/A6. B. Fellmuth will add a sentence to the MeP-K to clarify the relationship between the ITS-90 and the kelvin.

Status: Completed

CCT28/A7. S. Picard will move the CCT/08-19-rev document to the restricted area of the BIPM CCT web site.

Status: Completed

CCT28/A8. WG-SP to add a statement related to climate in its revision of the CCT Strategic Planning Document.

Status: Completed

CCT28/A9. WG-CTh Chair will draft ToR and tasks for the TG-CTh-ET (Emerging technologies) and suggest members to the CCT president.

Status: Completed

3 Comparisons

3.1 Report from WG- KC, Andrea Peruzzi (NRC)

Dr A. Peruzzi, Chairperson for the Working Group for Key Comparisons, presented the activities of the Working Group for Key Comparisons (WG-KC) since the 2017 CCT meeting [CCT/20-28]. He reminded the participants on the terms of reference and tasks for the WG.

The Working Group has presently 13 members. The former member Dr. Y. Yamada (NMIJ AIST) retired in 2019 and Dr A. Peruzzi thanked him for his precious contribution over the years. Shortly before the first session of the 29th CCT meeting the WG-KC was informed that Dr Rod White (MSL), also member of the group, will retire at the end of October 2020. It is possible that Dr R. White will contribute to the group on a personal basis after his retirement. To include competence on thermodynamic quantities Dr M. Akoshima (NMIJ AIST) was proposed as a new member of the WG-KC. The members of the WG-KC have unanimously agreed that Dr Akoshima could become a new member of the WG. If the president of the CCT does not have any objection Dr. Peruzzi would be happy to welcome Dr. Akoshima as a new member of the group.

Dr A. Peruzzi gave statistics on the number of comparisons since June 2017: 44 comparisons were treated of which 14 comparisons were approved, 1 comparison was declared abandoned and 4 supplementary RMO comparisons did not gain WG-KC approval.

He drew the attention to 20 “silent” comparisons for which no progress has been reported to the WG-KC in the last 5 years. The TC-T Chairs have been invited to contact the pilots and Dr S. Picard has already contacted the pilots for the CCT comparisons concerned.

Dr. A Peruzzi observes that not all pilots are aware of the review process as described in CIPM MRA-D-05 ([Measurement comparisons in the CIPM MRA](#)) and the associated [specific rules implemented by the CCT](#):

- The technical protocol and the final report of all CCT and RMO key comparisons, and possible CCT supplementary comparisons, must be formally approved by the WG-KC.
- Supplementary RMO comparisons can be agreed, conducted and evaluated within the respective RMO. However, on request the WG-KC will review both the technical protocol and final report for these comparisons.

Small deviations – e.g. not registering the comparison in the KCDB before start – are less serious compared to the lack of submission of the technical protocol to the WG-KC before starting a key comparison and omitting providing revised versions for approval. These omissions can reflect into serious flaws in the final reports and even prevent their approval. As a help for the pilots, Dr A. Peruzzi suggests adopting a checklist to become available on the CCT web (CCT/20-51).

The WG-KC recommends that the TC-T chairs review the technical protocols and comparison reports before submitting these to the WG-KC.

Dr Peruzzi reported on discussion linked to on how to make a recently published document “Uncertainties in the realization of ITS-90 metal freezing points using sealed cells” , presently included as an appendix in “Guide to the realization of the ITS-90” Chapter 2.4 “Metal fixed points for contact thermometry” https://www.bipm.org/utls/common/pdf/ITS-90/Guide ITS-90_2_4_MetalFixedPoints_Appendix-1_2018.pdf , more visible. As many institutes rely on sealed cells for their ITS-90 realization, the question rises whether these cells can be regarded as an

independent realization of the ITS-90 or if they need traceability. He called for a CCT position on this issue².

The need for a repeat of the CCT-K6 concerning humidity was highlighted. The WG-KC position is to complete the key comparisons on humidity presently active before a new comparison is started. This will be discussed when the activity from the Working Group for Humidity will be reported at a later session.

The WG-KC considers that a key comparison for thermodynamic temperature seems premature.

Dr A. Peruzzi ended his presentation by raising the question if there is a need for a common CCT framework on KC analysis.

Dr Y. Duan thanked the WG-KC for their extensive work and invited for comments.

3.2 Discussion

Prof G. Machin (NPL) gave information on the CCT-K10 (listed as a silent comparison) for which a Draft B will be reached by the end of the year. He will ask his colleague Dr. H. McEvoy to send Dr. Peruzzi an update about this comparison. Furthermore, he informed CCT that WG-NCTh is advising a new CMC review protocol for thermodynamic temperatures at high temperatures. Although this review protocol is effectively ready, this comparison will not be initiated before that the CCT-K10 has been completed.

Dr H. Yoon (NIST) asked what the criteria had been to disapprove the supplementary comparisons mentioned in the presentation. Dr A. Peruzzi answered that some comparisons were not compliant with the CIPM MRA requirements. He gave an example for the absence of an uncertainty budget.

Dr M. Milton thanked Dr A. Peruzzi and the working group for their hard work. He appreciated the highlight on the “silent” comparison which is an issue for the Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB). Giving an example of a “silent” comparison, he asked which are the next steps that will be taken. Dr A. Peruzzi referred to the pilot, which Dr S. Picard had contacted. She had received feedback on several comparison where the pilots had requested that the comparisons remain in the KCDB and the reports will be completed soon. Dr M. Milton gave examples of several RMO “silent” comparison still indicated as “Planned” and suggested to remove these until they start. Dr A. Peruzzi agreed, and Dr S. Picard confirmed that the APMP had been contacted on this specific issue. Dr Y. Duan emphasized that, if the pilots keep these comparisons that started a long time ago, it is necessary that they are completed soon, or they should be removed.

Dr A. Peruzzi asked Dr M. Milton if the JCRB has issued a strict rule that can be referred to as support when treating “silent” comparisons. Dr M. Milton indicated that no strict rule had been issued by the JCRB but that the RMOs, members of the JCRB, had the possibility to adopt a rule. The JCRB has drawn a limit at 5 years, comparisons dating since more than 10 years as listed represent much work for the institutes that in some cases are wasted.

Dr H. Yoon gave an example of an informal feedback at the most recent meeting of TEMPMEKO in 2019 that if the CCT-K9 was not completed in a short delay, another institute would do the

² Sealed metal fixed point cells will be discussed at session 4.

reporting. Recalling the large amount of work associated to the measurements, analysis and reporting, he asks the WG-KC to consider establishing a plan B at a certain time to force the pilot lab to provide the report. Dr M. Milton informed that other Consultative Committees had approached this problem by reducing the requirements of information in the final report. He suggests the WG-KC to reflect on how to reduce the burden of the piloting institute to speed up the process.

Dr S. Bell (NPL) suggested that the decision of the outcome of the RMO comparison should be in the hands of the RMOs. Dr S. Picard confirmed that this was the outcome of the WG-KC meeting.

Dr. I. Yang (KRISS) informed that in several cases the pilot had forgotten to ask to update the information included in the KCDB and had in fact progressed. He encouraged his TC-T colleagues to write to the KCDB Office and ask for update when applicable. Dr A. Peruzzi thanked Dr. I. Yang for his comment. He highlights that nevertheless, for the comparison he has listed as “silent”, no feedback to the WG-KC has been made over 5 years – it is not so much about updating the KCDB as contacting the WG-KC and present a Draft A or a Draft B report in time.

Dr Y. Duan asked the pilots of CCT-K1.1 and CCT-S3, started more than 10 years ago to complete the comparisons soon and indicate the time for completion. Dr H. Yoon confirmed in his role as the NIST delegate to conclude on the CCT-K1.1 with his management. Dr J.-R Filtz (LNE), chair for the Task Group for thermodynamic quantities, encourages the pilot of the CCT-S3 to complete the comparison soon.

Dr Y. Duan concluded the discussion by inviting new TC-T Chairs to take part of the information issued by the CIPM and CCT.

3.3 Status report on CCT- K9, Howard Yoon (NIST)

Dr H. Yoon presented that status of the CCT-K9 [CCT/20-30]. The draft of the technical protocol, measurements, analysis and reporting has involved four different persons. The comparison has lasted for a long time, but the projected timeline was extremely optimistic, and there are lessons to be learned. It started in 2011 – the measurements lasted four years – and the long duration has led to that many persons who participated initially are no longer involved. The comparison was ambitious, covering repeated measurements at fixed points from Ar (83.8058 K) to Zn (692.677 K). It has been carried out in a collapsed-star shape, initially involving 15 institutes.

Dr H. Yoon draws the attention to that, although the participating institutes selected their transfer standards, almost half of all thermometers failed the reproducibility criteria. Furthermore, many attending persons are not anymore involved in this key comparison for several reasons. This seems to be a challenge for all large key comparisons of this type and needs to be addressed by all CCs. A Draft A was presented to the participants in September 2020. It displayed the results at each fixed point where the institutes were not indicated. The results showed an unexpected large number of outliers, in particular at the Zn point, the Ga point and the Ar point. The comparison has allowed increased knowledge of this subject, for example outliers at the Zn fixed point could be explained by an under-estimate of radiative losses, and information on this has been provided by the NPL. He suspected that outliers might be explained by over-optimistic uncertainty budgets of participants and pilot and an error within the argon apparatus of the pilot institute.

Dr H. Yoon underscores the importance of comparisons by being a tool to test the uncertainties – you cannot deny what you observe.

Consequently, the NIST is presently refurbishing the laboratory used for the realization of the ITS-90. Nevertheless, and although the issuing of data has taken more time than expected, the results are very useful for the participants. A revised version of the Draft A will be distributed to the participants by 2020. Dr H. Yoon reassures that the results are really on their way.

Dr Y. Duan thanked Dr H. Yoon and invited for comments.

Dr D. del Campo (CEM) asked about the origin of the intended changes of some uncertainties in the final draft A report, mentioned during the presentation. Dr H. Yoon explained that it is not possible to alter arbitrarily uncertainty budgets without having a physical reason. He explained that there could be small changes due to uncertainties that were not considered or over-estimated by double counting such as the repeatability at NIST. But he does not believe that by these refined adjustments the results of the participants come closer to the KCRV or their uncertainties can be expanded so that they overlap the KCRV. Dr Yoon expressed his conviction that there are physical reasons for the outliers which must be identified by the participants. As an example, he mentioned that at NIST a thermal leak at the argon fixed point was not taken into account.

Dr I. Yang (KRISS) asked about a foreseen date for the Draft B. Dr H. Yoon replied that this is under discussion with Dr A. Peruzzi – it is possible that some additional adjustments need to be made to the uncertainty of the key comparison reference value(s). Dr A. Peruzzi confided that he believed the transition from Draft A to Draft B should not take more than 2 or 3 months. Dr Y. Duan expressed his satisfaction to see this recent progress and is looking forward for the Draft B.

3.4 Participation on CCT-K7.2021, A. Peruzzi (NRC)

The first comparison on water triple point cells (WTPCs), CCT-K7, was carried out from 2002 to 2004 and need of a repeat of this comparison was identified as high priority at the 28th CCT meeting. Although the new definition of the kelvin no longer relies on the WTP, the WTPCs continue to play a fundamental role in the realization of the ITS-90, where many institutes consider the isotopic composition of the water.

The NRC has offered, and has been accepted by the CCT, to act as the pilot institute. This repeat comparison, CCT-K7.2021, has attracted 19 members of the CCT to participate: (CEM, CENAM, INMETRO, INRIM, IPQ, KRISS, LNE/Cnam, MSL, NIM, NIST, NMIA, NMIJ AIST, NMISA, NPL, NRC (pilot), PTB, UME, VNIIM and VSL³). The participants are well distributed on the different RMOs [CCT/20-29].

A “kick-off” meeting was held in September 2020 and the draft of the technical protocol is expected to be distributed to the participants before the end of September 2020. A coordinating group composed by A. Peruzzi (NRC), S. Dedyulin (NRC), R. White (MSL) and A. Possolo (NIST) was formed to harmonize the uncertainty budgets, choosing the methods and software tools for the analysis.

³ During his presentation, Dr A. Peruzzi asked if other members of the CCT wished to participate. The VSL asked to participate. Dr. A. Peruzzi did not see a larger problem for this and accepted the request.

The comparison will be carried out in a collapsed-star form where each participant will use one transfer cell. Only national reference based on fused silica cells, for which a correction of the isotopic contents is applied, will be considered for the calculation of the key comparison reference value. The transport of the cells is delicate. For this purpose, the NRC has taken part of the contents of “MSL Technical Guide 44: Shipping TPW Cells” [CCT/20-65] and has asked for advice on transportation from Isotech/Fluke.

Dr A. Peruzzi also presented information on how the comparison will be carried out, and data reduction.

The comparison is planned to start in April 2021, with the first Draft A report issued before July 2022.

Dr Y. Duan thanked Dr A. Peruzzi and invited for comments.

Dr M. Sadli (LNE/Cnam) expressed his support for employing a coordinating group which can simplify the work but wondered to which extent blindness could be preserved. Dr A. Peruzzi clarified that from the point of view of the results there is no difference. From the point of view of the blindness regarding the results there is also no change. Of course, the pilot laboratory will not be blind, but all the other participants will be blind.

3.5 Notice on the CCT TG-NCTh-BTM, G. Machin (NPL)

Dr G. Machin, , Chairperson for the Task Group for Body Temperature Measurements, informed on the recent establishment of this new task group (TG-NCTh-BTM), dedicated to Body Temperature Measurements, tasked under the CCT Working Group for Non-Contact Thermometry [CCT/20-31]. The initial focus will be to improve non-contact body temperature measurements to establish reliable clinical thermometry on a global basis.

The objectives have been split into four different sub-groups concentrating on⁴ i) piloting a new key comparison for body temperature thermometers (X. Lu (NIM)), ii) collect and consolidate best practice/standards of body temperature scanning (I. Puslik (MIRS/UL-FE/LMK)), iii) collect and summarize best practice/standards of body temperature measurements (M.-J. Martin (CEM)), iv) review standards and interact with standardization bodies (L. Wang (NMC, A*STAR)).

Dr D. del Campo (CEM) has accepted to establish a forum of users and suppliers of body temperature measurement devices and to establish an appropriate link with the World Health Organization.

A “kick-off meeting” was held in July 2020, a letter was recently addressed to *Thermology International*, and a questionnaire is presently being circulated to all RMO TC-T Chairs about current practice of body temperature measurements.

A preliminary plan for the key comparison is being established where the comparison will be carried out in sub-groups.

Dr G. Machin presented the tasks of each sub-group and the interactions with the RMOs and the targeted objectives of 2021, stressing on the importance of the TG members to join the sub-group on standards to push metrology forward in this field.

⁴ Coordinators indicated within parenthesis.

Dr Y. Duan complimented Dr G. Machin and the Task Group members for the rapid progress that has been made. He invited for comments.

Dr D. del Campo encouraged the TC-T Chairs to ensure a wide source for replies on the questionnaire that has been launched.

4 Scientific presentation, C. Gaiser (PTB)

Dr C. Gaiser gave the presentation “The future of contact thermometry after the redefined kelvin” [CCT/20-52].

5. Actions and Decisions

The following actions and decisions were identified during the session:

Actions

CCT29/A1. S. Picard will publish the WG-KC check list on the CCT web site.

CCT29/A2. NIST will send the Final Draft A of the CCT-K9 to participants by 1 December 2020.

CCT29/A3. The pilot institutes of CCT-K1.1 (NIST) and CCT-S3 (NMIJ AIST) are invited to inform the CCT on the timeline for completion.

Decisions

CCT29/D1. Dr M. Akoshima (NMIJ AIST) will become member of the Working Group for Key Comparisons.

Dr S. Rudtsch, Rapporteur

November 2020