



54th CIML Meeting - Working Document

Additional Meeting Document

54 CIML AMD 7.4

2019-10-11

**Agenda item 7.4: Update on the work of the Consultative Committee for
Units (CCU)**

CCU Meeting Report, 8-9 October 2019**To: CIML**

As the OIML representative on the Consultative Committee for Units (CCU), I have attended the 24th CCU meeting, which took place on 8 and 9 October 2019. Three important topics (namely a definition of the term “unit”, angles and dimensionless quantities, and SI in the digital world) on the agenda (enclosed) have been identified by CCU Executive Secretary, Dr. Estefania de Mirandes and all delegates of CCU members and liaisons were welcomed to share the opinion of their institute or organisation on these three subjects by a short (5 min to 10 min each) presentation or by a written position. OIML TC 2 asked all its members to provide such input and collected this information from 4 member states. The OIML written position was prepared based on that material and sent to CCU before the meeting (enclosed). As these positions were largely opposing, no position was advocated as an OIML one.

During the meeting, the CCU president explained that the CCU has a consultative role, providing guidance to the CIPM. For the definition of the term “unit”, the CCU will provide either consensus recommendation or differing views on this issue to the CIPM, which will take decisions and inform JCGM on the Metre Convention position.

CCU discussed the definition of term "unit" at length. Currently the term "unit" is defined as a "quantity", while it is essentially proposed to change it to be defined as a "value of quantity". The unit "radian", dimensionless quantities and the unit Hz were discussed with a different opinions and proposals during a lively discussion. Although a consensus on all issues was sought, the discussion did not resolve much, if anything. However, it was a good opportunity to present arguments for various positions among the CCU members. It was consequently decided to establish a working group CCU-WG on unit, which would provide a scientific background from the available literature, aiming at finding consensus definitions/descriptions of the metrology terms. The CCU-WG on unit would provide a written report in one year time. The report would be available to the CCU member and liaison organisations to make their own, preferably consensus, position on the topics. These position will be collected by CCU and discussed at its next meeting in September 2021. This process will therefore take at least two years, before the CIPM position would be officially given to the JCGM.

Additional to these topics, OIML as a liaison organisation will be asked to respond to a CCU questionnaire related to the SI units.

dr. Rado Lapuh
Metrology Institute of the Republic of Slovenia

Draft Agenda for the 24th meeting of CCU

Venue: Pavillon du Mail, BIPM, Sèvres, France.

Start: Tuesday 8 October 2019 at 09:00

1. Opening of the meeting
 - 1.1 Welcoming remarks and introduction
 - 1.2 Welcoming from the BIPM Director
 - 1.3 Approval of the Agenda
 - 1.4 Appointment of the *rapporteur*
 - 1.5 Update from the CIPM
2. President's report
3. CODATA TGFC report on the 2018 CODATA adjustment
4. Reports from the Consultative Committees
5. Comments on written reports from other organizations and institutions: CIE, IAU, ICRU, IEC, IFCC, ISO, IUPAC, IUPAP, Académie des Sciences de Paris, OIML
6. Questionnaire for CCU members and stakeholders on the implementation of the new definitions of the SI.
7. Discussion on the definition of the term "unit".
8. Discussion on angles and dimensionless quantities
9. Discussion on the SI in the digital world
10. Discussion on the possible extension of the available range of SI prefixes
11. CCU Strategy for the next 10 years
12. Any other business
13. Date of the next CCU meeting

Draft agenda for the half-day meeting devoted to the second

Venue: Pavillon du Mail, BIPM, Sèvres, France.

Start: Wednesday 9 October 2019 at 14:00

1. The second in the revised SI
2. Impact of the redefinition of the second in the concerned communities:
 - a. IAU (International astronomical union)
 - b. URSI (International union of radio science)
 - c. IUGG (International union of geodesy and geophysics)
 - d. IUT (International telecommunication union)
3. Timescales, clocks, time and frequency comparisons
4. Roadmap towards the redefinition of the second

OIML TC 2 Units of measurement

CCU Meeting, 8 October 2019

To: P-member and O-member contacts of TC 2

Dear colleagues,

As the OIML representative on the Consultative Committee for Units (CCU), I have received information regarding the 24th CCU meeting, which will be held on 8 October 2019. Three important topics on the agenda have been identified by CCU Executive Secretary, Dr. Estefania de Mirandes (see the CCU meeting agenda at TC2_P0_N002, [11]), which might also be of importance to the OIML community. All delegates of CCU members and liaisons are welcomed to share the opinion of their institute or organisation on these three subjects by a short (5 min to 10 min each) presentation.

These three relevant topics from the agenda are:

7) **Discussion on the definition of the term “unit”** (remained contentious during the drafting of the 9th Brochure). There is no clear summary of the discussion found in the Rapport-CCU23 from the last CCU meeting and also no other direct reference. A comprehensive discussion on the “quantity” and “unit” definition and its meaning with historic development is given in the Boer’s paper [13]. Current definition is given in VIM [12] (and equivalently in ISO 80000-1:2009). The term “unit” is alternatively “defined” in references [1, 4 and 8] and used in remaining references.

Basically, there are two equivalent definitions in VIM and ISO 80000-1:2009. The VIM definition [12] is stating:

Unit of measurement: real scalar quantity, defined and adopted by convention, with which any other quantity of the same kind can be compared to express the ratio of the two quantities as a number

(for your reference, the ISO 80000-1:2009 definition is stating: *Unit of measurement: real scalar quantity, defined and adopted by convention, with which any other quantity of the same kind can be compared to express the ratio of the second quantity to the first one as a number*).

However, the definition discussed, but not accepted for the 9th revision of the SI Brochure as given in [1] is:

The value of a quantity Q is the product of a number $\{Q\}$ and a unit $[Q]$:

$$Q = \{Q\}[Q].$$

The unit is a particular example of the value of a quantity, defined by convention, which is used as a reference, and the number is the ratio of the value of the quantity to the unit. For a particular quantity different units may be used. For example the value of the speed v of a particle may be expressed as $v = 25 \text{ m/s}$ or $v = 90 \text{ km/h}$, where metre per second and kilometre per hour are alternative units for the same value of the quantity speed.

When a measurement result of a quantity is reported, the estimated value of the measurand (the quantity being measured), and the uncertainty associated with that value are necessary. Both are expressed in the same unit.

The VIM (and ISO 80000-1:2009) defines the unit to be a quantity, while the proposal at the 23rd CCU defines the unit as a quantity value. As these two definitions contradict each other, it is important to formulate the OIML opinion on this topic and present it at the next CCU.

8) **Discussion on angles and dimensionless quantities** (remained contentious during the drafting of the 9th Brochure). There is no clear summary of the discussion found in the Rapport-CCU23 from the last CCU meeting. However, the reference [1] gives one view to the issue directly and [6] is also discussing it. The argument is that the angle (cycle or radian) should always be stated as a unit (like for the frequency: 1 cyl/s or 2π rad Hz).

9) **Discussion on the SI in the digital world.** This is a new initiative. The imperative here is to develop the SI system in such a way that computers would be able to interpret measurement results and quantities unambiguously. Several proposals were already published [5-9], but while the solution would be highly beneficial for a modern world, some changes could come at a rather high price, calling for compromises.

Further information (all references) on these topics is provided as separate documents posted on the Workspace.

Based solely on the material available, it is hard to provide a clear OIML position to start working on. For 7), the current VIM definition is clearly a starting point, for 8) reference [1] and for 9) a steady development toward consistent and unambiguous quantity and unit system.

It would be beneficial to agree the OIML position on these topics in order that they can be presented at the CCU meeting. I would therefore welcome any feedback on the proposed OIML position outlined above before the deadline of **30 August 2019**.

If you have any questions regarding the above, please do not hesitate to contact me.

Best regards,

Dr. Rado Lapuh

25th July 2019

References:

- [1] Mills, On Dimensionless Quantities and Units, June 2019
- [2] R. J. C. Brown, Extending the available range of SI prefixes
- [3] R. J. C. Brown, Considerations on Compound SI prefixes, Measurement, 2019
- [4] R. J. C. Brown, On the nature of SI prefixes and the requirements for extending the available range, Measurement, 2019
- [5] M. P. Foster, Disambiguating the SI notation would guarantee its correct parsing, Proc. R. Soc, 2008
- [6] M. P. Foster, The next 50 years of the SI: a review of the opportunities for the e-Science age, Metrologia, 2010
- [7] M. P. Foster, Principles for constructing notation in unit systems and their application to the SI, Accred Qual Assur 2012
- [8] M. P. Foster, Quantities, units and computing, Computer Standards & Interfaces, 2013
- [9] D. Pražák, Graecophile's view of the SI notation, Accred Qual Assur 2015
- [10] BIPM, Consultative Committee for Units (CCU), Report of the 23rd meeting (5-6 September 2017)
- [11] Draft Agenda for the 24th meeting of CCU
- [12] JCGM 200:2012, International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM 3rd edition), <http://viml.oiml.info>
- [13] J. de Boer, On the History of Quantity Calculus and the International System, Metrologia, 1995, <https://iopscience.iop.org/article/10.1088/0026-1394/31/6/001/meta>

Actions and decisions from the 24th meeting of the CCU 2019

Actions

- A1. Improve liaison between ISO TC 12, IEC TC 25, IUPAP C2 and the CIPM and its CCs for future revision of relevant standards for units. (CCU WG on units, to make a proposal)
- A2. Add a question on implementation of revised SI within national legal metrological framework to the questionnaire for stakeholders. (M. Stock)
- A3. Discuss questionnaire for stakeholders at the CIPM meeting (about coordination with OIML about question on legal implementation, and part C for academic organizations) and at NMI Directors meeting next week (send to which NMIs) (J. Ullrich, M. Milton)
- A4. CCU WG on units to make a proposal to CCU on the definition of “unit”, “quantity”, “value of quantity” by end Sept. 2020, possible extension of scope to be discussed by CIPM next week (15-16 Oct 2020).
- A5. NMI members and liaison organizations to bring official opinion on definition of “unit” and units for angles and frequencies to next CCU meeting (2021).
- A6. R. Brown to prepare summary on prefix discussion for J. Ullrich, who will present topic to CIPM next week (15-16 Oct 2020).
- A7. Proposal of INRIM as new CCU member to CIPM. (J. Ullrich)
- A8. Proposal of NSC IM as new CCU observer to CIPM. (J.Ullrich)
- A9. Proposal of liaison with IMU. (J. Ullrich)
- A10. Invite IMU for next CCU meeting. (J. Ullrich)
- A11. Check with all attendees on open publication of working documents and presentation files (M. Stock)

Decisions

- D1. CCU Strategy Document approved with some minor changes
- D2. ToR of WG-S approved
- D3. WG on “unit” formed: NSC IM (chair), NRC, NMIJ, NPL, NIST, INRIM, PTB, CEM, METAS, LNE, Rosstandart, M. Himbert
- D4. WG on angles and dimensionless quantities closed
- D5. Next meeting of CCU: September 2021
- D6: Next meeting of CCU WG-S: February 2021