

Strategy for the Consultative Committee for Units, CCU, for the period 2019 to 2026

1. General Information:

Name:

Consultative Committee for Units (CCU)

Working Groups:

CCU Working group on Strategy (CCU-WG-S) and *ad-hoc* Working Groups and Task Groups when necessary on a temporary basis

Date established:

1964, to replace the "Commission for the System of Units", set up by the CIPM in 1954

Number of Members:

11 Members, No Observers, 10 Liaisons and 3 Honorary Members

Number of participants at last meeting:

65

Periodicity of meetings:

1 to 3 years

Date of last meeting:

5 and 6 September 2017, its 23rd meeting

President:

Prof Joachim Ullrich, from 1st January 2014

2. Terms of Reference

The work of the CCU is concerned with matters related to:

- Providing advice to the CIPM about units of measurement, in general, overall consistency and harmonisation.
- The development and improvement of the International System of Units (SI), the preparation of successive editions of the SI Brochure and supportive documents, and any other summaries relevant for metrology institutes, industry, academia and schools, etc.
- Providing information and advice on units and their use to a wide range of stakeholders.

3. Description of activities and achievements up to and including 2019

From its creation in 1964 the main task of the CCU has been to oversee the development of the SI and to prepare the successive editions of the SI reference document, the SI Brochure, now in its 9th edition. In its early years the CCU made many important recommendations and took the initiative to build what is now the formal structure of the SI, with its base and derived units, units with special names, and the formalism of their use. The first four editions of the Brochure, beginning in 1970, were published in French only but since the 5th edition in 1985 it has been published bilingually in French and English.

Great care is taken with the language, not only for the accuracy of the meaning but also because it is translated into many other languages as well as being used by people whose mother tongues are neither French nor English. The current edition, the 9th, has been published in 2019 and included a four-page Concise Summary. The Brochure is freely available on the BIPM website but is also presently published in hardcopy. The SI Brochure is the most important and widely used publication of the BIPM.

The most important activity of the CCU in recent years has been the preparation of a major revision of the SI, which has been referred to as the “Revised SI”. This revision was adopted by the 26th CGPM in 16 November 2018 and came into force in 20 May 2019. The revision includes new definitions of the kilogram, ampere, kelvin and mole, the rewording of the definitions of the second, metre and candela, in order for all of them to appear consistent in form, and a new way of presenting the entire system by fixing the numerical values of a set of seven “defining constants”.

The revision of the SI is the subject of Resolution 1 of the 26th CGPM. The proposed changes embodied in Resolution 1 were widely discussed in the respective Consultative Committees, in the CCU and in scientific meetings outside the BIPM. The CCU had the responsibility of bringing together the views of the individual Consultative Committees with the many international bodies represented on the CCU and arriving at a consensus. This was what happened in 2017 when the CCU supported the decision of revising the SI embodied in the draft which became Resolution 1 of the 26th CGPM.

As part of the task of informing the public about the revision of the SI, a special page of the BIPM website was created. This is not only to inform but also to stimulate discussion and encourage awareness of the changes. It includes a file of Frequently Asked Questions (in French and in English), the rationale behind the change as well as the present SI Brochure and Concise Summary.

The CCU working group on angles and dimensionless quantities (WGADQ) met on several occasions to examine the treatment that should be given in the 9th Brochure to “dimensionless quantities” as angles, frequency rates and counting quantities. The possible introduction of the radian as a base unit was considered as well as the introduction of the dimension “number” along with the unit “one”. No consensus was reached on either subject so, after consideration, the issues were brought to the CIPM which decided that the 9th edition of the Brochure should treat both topics according to CGPM decisions currently in force.

4. Stakeholders (who they are and their level of involvement)

The bodies having a direct interest and concern in the activities of the CCU, are:

1. the CIPM, which must be properly advised on matters related to the SI,
2. the National Metrology Institutes and the Designated Institutes, which use the SI every day in their business, and
3. the international organizations that are in *liaison* with the CCU, which disseminate the SI to their members.

On a much wider scale, a clear and accessible statement of the SI and how it should be used is essential not only for the scientific, technical, industrial and educational communities but also for society as a whole. Research and development, manufacturing, trade, medicine, protection of the environment and consumer protection all depend on accurate, reliable and comparable measurements, hence on the proper application of the SI. For all these reasons an authoritative guide to the SI is required, which is provided by the SI Brochure. These days, such information is sought online and thus the BIPM website plays and will play in the future an increasingly important role.

5. Future Scan (2019-2030)

The decision for the revision of the SI that took place in November 2018 and came into force in May 2019 has closed a very intense phase of activity over the last decade in which the CCU was mostly devoted to this revision. Therefore, in the years following the redefinition, the CCU is expected to reorient its scope and activities, within its terms of reference, to fulfil its mission of developing and improving the SI in all areas. In parallel, the CCU will naturally monitor the implementation of the revised SI.

Specific tasks starting from 2019:

- The main tasks expected for the CCU in the period 2019-2026 will concern time and frequency metrology and will be carried out in close collaboration with the CCTF. In particular:

The performance of optical clocks has surpassed that of the best primary caesium clock fountains and keeps improving. A roadmap was developed by the CCTF to specify the timeline and the necessary milestones to be achieved before a redefinition of the second in terms of an optical transition can take place. The CCU will provide input into this process and other concepts highlighted in the CCTF strategy (e.g. high accuracy measurements of optical frequency ratios, close connection between the dissemination of the time unit and the timescales, etc.). The CCU will also review the impact of proposals for the redefinition of the second on other fields of metrology.

- Outside time metrology, one of the major tasks for the CCU in the years following the redefinition will be to monitor the implementation of the revised SI in the different areas of metrology, in close collaboration with the relevant CCs. In this respect:

The CCU will consider conducting a survey among CCU members, liaisons, NMIs and stakeholders to gather feedback about the implementation of the changes associated with the revision of the SI in their own institutes, laboratories and organizations. The CCU will also collect the list of frequently asked

questions that CCU members and liaisons have received from their stakeholders related to the adopted changes. Longer term, after the redefinition, new realisations of the units in terms of the defining constants will emerge along with new proposals for the *mises en pratique*. The CCU will monitor these developments, document any improvements they allow, take care of the consistency of the overall system and provide scientific advice to the CIPM accordingly. The CCU will propose updates of the SI Brochure to the CIPM accordingly along with other updates that might become necessary.

In the years directly after the redefinition the CCU along with its President will keep working towards general acceptance of the SI revision.

- During the years that have preceded the revision of the SI, several issues have been object of debate and for some of them further consideration may be needed. In particular:

In the revised SI, the distinction between base units and derived units has been kept, both for historical reasons and for practical usefulness when carrying out dimensional analysis. Nevertheless, it is acknowledged in the current 9th edition of the SI Brochure that this distinction is, in principle, not anymore necessary. The CCU will review the advantages and drawbacks if this distinction were to be removed in future.

In the present SI, the seven defining constants have, formally, equal importance. Nevertheless, some of these constants are considered to be more fundamental than others, and the units they define to have a different character as well. The pertinence of establishing a formal hierarchy within the SI among the different defining constants, as well as a distinction between units for physical and physiological quantities could be interrogated

In the 9th SI Brochure, the treatment of so-called dimensionless quantities remains identical to that of the 8th Brochure reflecting the absence of consensus within the CCU working group on angles and dimensionless quantities (WGADQ) that examined this issue in view of implementing possible changes to the 9th SI Brochure. As this issue remains controversial, the CCU will review again the role of the radian, steradian and units for angles in general in the SI, as well as the use of the unit s^{-1} to express counting rates and also to express frequencies with the special name “hertz”. Units for counting quantities and the role of the unit “one” in the SI will be examined as well.

In recent times, there has been a pressing demand from part of the scientific community to have available ontologies providing consistent and unambiguous machine-readable descriptions of relevant concepts from the SI Brochure and their relations to provide a platform for automatic semantic interpretation of textual information related to units of measurement. These ontologies would also facilitate the exchange of data and knowledge between machines; they should be readable by both human experts and machines. A standard ontology language focused on the SI is currently missing. The CCU will examine these needs and will propose a suitable course of action to address them.

During the drafting process of the 9th SI Brochure, there was a rich debate within the CCU on the correct definition of the term “unit” in the Brochure. Due to past time constraints, the arguments exchanged would need further consideration and broader discussions. The CCU will examine again the definition of the term “unit” in the SI Brochure and remain at the disposal of the CIPM to examine the definition of other metrological terms if requested.

As science advances to address both larger and smaller domains, the need to expand the range of SI prefixes available to stakeholders will become more pressing. At present, names for the multiplying factors 10^{27} , 10^{-27} , 10^{30} and 10^{-30} are already being proposed by the popular science media. The CCU should provide advice accordingly.

6. Appendix 1: Details of CCU Working Groups

6.1 CCU working group on Strategy

Date established:

2017

Number of Members:

8

Number of participants at last meeting:

8

Periodicity of meetings:

1 year

Date of last meeting:

25 January 2019

Chairperson:

Prof Joachim Ullrich,

6.1.1. Terms of Reference

The work of the CCU-WG-S is to:

- Ensure that relevant developments in science, particularly in areas not covered by other CCs, are monitored by the CCU and propose suitable actions.
- Propose a long term vision for the CCU covering the next ten years and to establish and maintain a strategic planning document.
- Advise the CCU on the optimal operational structure of the CCU and its working groups.
- Establish practices to ensure an effective linkage between organizations in liaison and in cooperation with the CCU.
- Suggest to the CCU possible future revisions, additional Annexes to the SI Brochure or other supporting documents, as appropriate.