Bureau International des Poids et Mesures

Consultative Committee for Units (CCU)

Report of the 15th meeting
(17–18 April 2003)
to the International Committee for Weights and Measures

Comité international des poids et mesures

Bureau international des poids et mesures

Organisation intergouvernementale de la Convention du Mètre

Note:

Following a decision made by the International Committee for Weights and Measures at its 92nd meeting in October 2003, Reports of meetings of Consultative Committees will henceforth be published only on the BIPM website in the form presented here.

Full bilingual printed versions in French and English will no longer appear.

Working documents for the meetings are listed at the end of each Report and those which the Consultative Committee decides are for public use are available also on the website.

T.J.Quinn,
Director BIPM,
November 2003.

LIST OF MEMBERS OF THE CONSULTATIVE COMMITTEE FOR UNITS

as of 17 April 2003

President

I.M. Mills, International Union of Pure and Applied Chemistry [IUPAC], Commission STU.

Executive Secretary

P.W. Martin, International Bureau of Weights and Measures [BIPM], Sèvres.

Members

International Astronomical Union [IAU].

International Commission on Illumination [CIE].

International Commission on Radiation Units and Measurements [ICRU].

International Electrotechnical Commission [IEC], Technical Committee 25.

International Federation of Clinical Chemistry and Laboratory Medicine [IFCC].

International Organization for Standardization [ISO], Technical Committee 12.

International Organization of Legal Metrology [OIML].

International Union of Pure and Applied Chemistry [IUPAC], Commission STU.

International Union of Pure and Applied Physics [IUPAP], Commission SUN-AMCO.

National Institute of Metrology [NIM], Beijing.

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

National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology [NMIJ/AIST], Tsukuba.

National Physical Laboratory [NPL], Teddington.

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig and Berlin.

State Committee of the Russian Federation for Standardization and Metrology [Gosstandart], Moscow.

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

Observer

Centro Español de Metrología [CEM], Madrid.

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

The Consultative Committee for Units (CCU) held its 15th meeting at the International Bureau of Weights and Measures, at Sèvres, on 17 and 18 April 2003.

The following were present: J. Bastie (BNM-INM), C.A. Borghi (IEC/TC 25), S.V. Débarbat (OP, IAU), R. Dybkaer (IFCC), J. Flowers (NPL), K. Fujii (NMIJ/AIST), M. Himbert (BNM-INM), A. Leitner (OIML), I.M. Mills (President of the CCU, IUPAC), T.J. Quinn (Director of the BIPM), B. Siebert (PTB), B.N. Taylor (NIST), A.J. Thor (ISO/TC12).

Also present: P. Giacomo (Director Emeritus of the BIPM), P.W. Martin (Executive Secretary, BIPM), J. Miles (BIPM, for part of the meeting).

Guests: Mrs Zhao Yan and Prof. Zhao Dazun (Beijing).

Apologies for absence were received from B.W. Petley (IUPAP-SUN-AMCO), A.G. San Román (CEM), S.M. Seltzer (ICRU), R. Watters (NIST).

Prof. Mills welcomed new delegates: Dr K. Fujii, Prof. M. Himbert, Dr A. Leitner, Dr B. Siebert and guests Mrs Zhao Yan, Prof. Zhao Dazun.

Dr J. Flowers was appointed rapporteur.

2 RESPONSIBILITIES AND ACTIVITIES OF THE CCU

Prof. Mills reminded the CCU of its responsibilities as specified in the report of the 14th meeting held in 2001:

- the preparation of the 8th edition of the SI Brochure;
- consideration of recommendations for future changes in definitions of SI base units;
- maintaining and revising the SI;
- promulgating the correct use of the SI.

With regard to the report of the 14th meeting, Dr Dybkaer pointed out that the last sentence of the second paragraph of section 9 (p. 27 of the French text, p. 64 of the English text) was not factually correct and should be removed from the record; the committee gave its approval.

3 PRESIDENT'S REPORT

The President reported that there had been two CIPM meetings since the last meeting of the CCU. At the CIPM meeting in October 2001 (90th meeting) he had reported that the CCU recommended the neper should be recognized as the (only) coherent unit of logarithmic decay, and recommended recognizing the bel and decibel as widely used non-coherent units. The reasons for this recommendation are summarized in the 2001 paper in *Metrologia* by Mills, Taylor and Thor. After a brief discussion this recommendation was approved, although without enthusiasm.

Although there was no meeting of the CCU in 2002, the President discussed the situation with many users of these units, and found widespread dissatisfaction with the proposal that only the neper should be recognized as a coherent SI unit. This arises from the fact that the decibel is very widely used as a unit, but the neper almost never used, by workers in the field. In fact most of the user community have difficulty in recalling the definition of the neper.

After discussion with experts in the field, and with colleagues on the CCU, the President decided to present a modified proposal to the CIPM at its meeting in 2002 (91st meeting), recommending that we should recognize *two* coherent SI units of logarithmic decay for *two slightly different quantities*: the neper for logarithmic amplitude ratio, and the bel for 'power-like quantities'. The justification for this is that for almost all applications in which the decibel (and by implication the bel) is used it is for power-like quantities for which it is not possible to define an amplitude function, because the power-like functions are not sinusoidal. Thus this proposal recognizes the way in which the bel and decibel are actually used by practitioners in the field, and also recognizes the logic behind the use of the neper for amplitude ratios. However, after a lengthy discussion the CIPM decided that it did not yet wish to make any change to the present situation, in which neither the neper nor the bel are recognized as SI units.

4 NEW EDITION OF THE SI BROCHURE

It was noted that any substantive changes to the SI require the approval of the CGPM; this meeting would consider only revisions of the wording and layout of the Brochure.

4.1 Preface

Prof. Mills proposed that he and the Director of the BIPM should again write the preface, and this was accepted.

Prof. Mills had circulated a working document on the revision of the SI Brochure prior to the meeting and the committee agreed to adopt this paper as a basis for discussion, together with other working documents subsequently submitted in response by committee members. The ordering of the following subsections corresponds to that of the President's working document.

4.2 General considerations

Dr Taylor emphasized the importance of the SI Brochure; it should be as complete and widely accessible as possible. Dr Quinn pointed out that the Brochure is a frequently visited part of the BIPM website.

It was agreed that it was impractical to circulate a draft of the Brochure outside the membership of the CCU. However, it was recognized that the completed document should be advertised widely. The meeting thought that the general layout of the Brochure and its division into sections and appendices were in general acceptable, affirming that the new edition should be fully available through a link on the BIPM web page, with all the associated search facilities.

4.2.1 Section 1

The committee considered that the historical note was not an engaging preamble and should be moved to become an introduction to Appendix 1. The section should start with a tutorial discussion on quantities and units, noting the advantages of a coherent system. The next subsection, 1.2, should describe the international system of quantities (ISQ) and the SI. After some discussion it was decided that, on a logical basis, the description of the ISQ should precede that of the SI. Subsection 1.3 will contain a more detailed discussion of coherence and dimensions in the SI. Subsection 1.4 will cover prefixes, while the topics in subsections 1.5 and 1.6 will remain unchanged, viz. 'Units in the framework of general relativity', and 'Legislation on units', respectively.

Prof. Mills indicated that he was willing to draft the new Section 1.

4.2.2 Section 2

The meeting felt that any major revision of the definitions of the base units was at least five years in the future and should not be considered at this time. However, in order to encourage input to any future changes, we should invite broad scientific discussion of the definition of the base units within both the Consultative Committees (CCs) and the scientific community in general.

There was a consensus that the current definitions should include a statement regarding the effect of each definition on fixing the value of one of the fundamental constants, such as is already included for the metre and the ampere. For example, in the case of the ampere the statement should read: 'Note that the effect of this definition is to fix the value of the permeability of vacuum (also known as the magnetic constant) at exactly $4\pi \times 10^{-7}$ H · m^{-1} in SI units'.

The CCU was of the opinion that the concepts of realization and definition of a unit are not sufficiently clearly explained, and that the appropriate place for an expanded discussion of this was in the preamble to Section 2.

To this end Dr Taylor agreed to draft a brief introduction to Chapter 2 of the Brochure that would deal with the difference between the definition of a unit and its realization. He also agreed to draft a brief discussion of this difference for inclusion in the introduction to Appendix 2 of the Brochure.

4.2.3 Website

Dr Janet Miles, the BIPM webmaster, gave a presentation of the draft BIPM website and the hypertext version of the 7th edition of the SI Brochure, which is expected to be on-line by the end of the summer. The meeting accorded its strong approval of the way in which the Brochure has been presented in the web version.

4.3 Marginal notes

There was general agreement to keep marginal notes in the new edition.

4.4 Nomenclature of the SI

The meeting accepted the new meanings of the names “SI Units”, “Units of the SI”, and “Coherent SI units”, as outlined in the minutes of the 14th meeting of the CCU (p. 23 of the French text, p. 61 of the English text) and advocated that they be explained in Section 1 of the Brochure.

Prof. Mills undertook to draft the inclusion of this as part of Section 1.

4.5 The introduction of the international system of quantities

It was agreed that a discussion of the international system of quantities, to be drafted by Prof. Mills, should also be included in the new text of Section 1.

4.6 Definitions of the base units

As mentioned in item (i), no major revisions are envisaged for at least five years.

4.7 Changing the prefixes da, h, k to D, H, K

The CCU decided to leave this matter in abeyance. Following a brief discussion, a similar conclusion was reached regarding any further extension to the SI prefixes. The reason for making no change in the prefixes is that any change, even small changes, will have extensive implications for the many documents in several languages derived from the Brochure, with consequent dangers of

confusion. The committee feels that even small changes should only be made when there is a strong case for change.

4.8 Binary multiples

A decision was made to include a marginal note discussing the binary multiples along the lines of that given on p.14 of the NIST Special Publication 330, 2001 edition, which is the US version of the 7th edition of the SI Brochure.

4.9 Greek letter mu for micro

It was acknowledged that in the past the limited choice of fonts has meant that the proper typeface for Greek mu has not always been available. The problem is expected to diminish, however, as improved software and printers become available. There was a consensus for making no change, for the same reasons as given in 4.7.

4.10 Dimensionless quantities, quantities of dimension one

The meeting agreed that more discussion was needed on the revision of subsection 2.2.3 of the current Brochure. This should include the meaning of dimensionless quantities or quantities of dimension one and units for such quantities. There was a long discussion on the merits of introducing a name for the unit 1, with a suggestion that it be the uno.

Prof. Thor drew attention to his paper, 'Adoption of one, symbol 1 as an SI base unit', which had been submitted as a working document.

Dr Taylor suggested that the uno could be introduced as a special device for use with prefixes only so that, for example, the usage ppm could become μU, but the uno would not be a unit. This met with some objections and it was pointed out that such a change would require the approval of the General Conference.

The president drew the discussion to a close without conclusion, proposing to draft a discussion document to circulate to other CCs and to the directors of national metrology institutes to solicit their views on the introduction of the uno. He will also draft a revised version of subsection 2.2.3, but without introducing the uno.

4.11 The neper and the bel

The meeting concurred that the neper, bel and decibel should all be included in the new version of Table 6. The wording proposed by Prof. Mills in his working document was approved, retaining the first sentence of the proposed text as footnotes, but moving the rest to the body of the text to prevent the footnotes from becoming too long.

It was suggested that ellipsis should follow the decimal conversion factors to indicate that they cannot be written as an exact decimal.

4.12 The uno

This discussion was covered under item 4.10.

4.13 Rearrangement of the Tables in Chapter 4

There was agreement that Tables 6 to 10 of the current Brochure represent too many categories with over-many fine distinctions between them. The discussion, which was continued at length the next day, is summarized here.

Opinion was agreed that the Brochure should strongly promote the use of the SI, pointing out its advantages. However, statements deprecating the use of non-SI units should be discouraged, to avoid alienating those who, for various reasons, may wish to continue to use such units. A proposal was accepted to delete the word 'effective' from the phrase 'effective cross section' in footnote (d) of Table 8.

Approval was given to include a discussion in Chapter 4 of biological measurements that cannot be expressed in terms of SI units, probably best inserted in the introductory text before section 4.1. Drs Quinn and Bastie undertook to draft a revision of the text for biological units following consultation with the World Health Organization (WHO).

4.14 Addition of more units that are determined experimentally

The committee reached the conclusion that no additional items should be added to the current Table 7. Although it is acknowledged that there are other constants used as units, such as atomic units, it was recognized that there are a number of sets of such units and that the list would grow unacceptably long.

4.15 Symbols for the astronomical unit, nautical mile and knot

The president had investigated the common practice for the symbols for these units, and had consulted a number of relevant bodies. No consensus has emerged, and such decisions are beyond the remit of the CCU, which covers only the SI.

The committee concluded that the Brochure should summarize current practice without making any positive recommendation regarding the symbols for these units.

Prof. Mills agreed to draft an appropriate footnote.

4.16 The dalton

The dalton (symbol Da) is used as a name for the unified atomic mass unit. It is widely used by polymer chemists and biochemists (see footnote (c) in Table 7 of the current Brochure). The CCU acknowledged that the name Dalton has advantages over 'unified atomic mass unit': it is shorter and works better with prefixes. The 'unification' between chemists and physicists which gave the unit its

name is now of historic interest only. A decision was taken to introduce the dalton into Table7, according it equal status with the unified atomic mass unit.

Following a question by Dr Taylor as to whether the CCU had the authority to make such a change, Prof. Mills agreed to draft a letter consulting IUPAP and IUPAC, to be reviewed by Drs Flowers and Dybkaer.

4.17 The symbol for the litre

Some members are unhappy with the continued use of both the symbols l and L for the litre. No preference for one over the other has emerged since the use of either was permitted. It was pointed out by Dr Leitner that legal metrology requires both. It was noted that ISO and IEC prefer the lower case l. The meeting agreed to make no change to the current acceptance of both symbols.

4.18 New version of Chapter 5

Dr Taylor proposed, and it was agreed, that we should extend the present Chapter 5. He will draft a revised version of this chapter along the lines of Sections 6 and 7 of the NIST Special Publication 811, 1995 edition. Dr Dybkaer suggested including the recommended form for table headings and labels on the axes of graphs, using the ratio of the quantity symbol to the unit. It should be pointed out that the symbols for the minute and second are primes, not apostrophes.

Dr Débarbat noted that the text needs to point out that the grouping of digits into threes with commas or points is not acceptable; only a space should be used.

Prof. Mills suggested that it would be helpful to include a number of examples demonstrating both the proper use and common misuse of SI names and symbols when expressing the values of quantities.

4.19 Relationship between absorbed dose and dose equivalent

Consideration was given to the working document submitted by Dr Seltzer (representing the ICRU) on the recommendation by Dr Allisy-Roberts of the BIPM that the factor N be removed from the relationship $H = Q \cdot N \cdot D$ (p. 52 of the French text, p. 127 of the English text). This was approved on the basis that the ICRU is the proper authority to sanction such a change.

Dr Siebert felt strongly that effective dose is not a quantity that should be included in the SI. There was a discussion on the term effective dose and the other quantities measured in terms of the sievert (Table 3). It was the opinion of Prof. Mills that the CCU should take further advice.

4.20 Ordering of Appendix 1

The decision was made to order Appendix 1 by date as was done in earlier editions and not by subject as was the case in the 7th edition. The cross-referencing should be extended to enhance the usefulness and effectiveness of the web edition.

4.21 Miscellaneous decisions on the Brochure layout

The CCU took the view that the SI Brochure should continue to follow the CIPM recommendation that the comma be used as the decimal marker in the French text and the point in the English text. Dr Flowers noted that some other aspects, such as the unit names, are language dependent but that the symbols never are. A note for translators would be welcome.

Further discussion focussed on the working document presented by Prof. Thor. The following decisions were approved by the meeting in addition to those accepted above:

1) There should be a note in the text to the effect that Tables 3 and 4 are just examples and by no means exhaustive.
2) In Table 2:

Replace ‘concentration (of amount of substance)’ with ‘amount-of-substance concentration’.

Footnote (a): Replace ‘The symbol “1”…’ with ‘The unit symbol “1”…’.

3) In Table 3:

Replace ‘quantity of heat’ with ‘amount of heat’.

Replace ‘quantity of electricity ’ with ‘amount of electricity’.

Replace ‘activity (referred to a radionucleide)’ with ‘activity (of a radionucleide)’.

4) The captions heading the last columns in Tables 3 and 4 do not match; they should both be plural.

4.22 Photobiological quantities

Mr Bastie gave a presentation on the working document he had submitted on photobiological quantities. He would like to see a paragraph in the Brochure explaining the use of these quantities. Dr Taylor suggested that the appropriate place would be in subsection 7 of Appendix 2 (pages 75 and 149 of the French and English texts, respectively). Dr Quinn said that it was an advantage not to have a new name and unit for each of these quantities. The CCU agreed to reconsider this issue after the CCPR had finished its work and produced its recommendation.

5 ANY OTHER BUSINESS; DATE OF THE NEXT MEETING

The president thanked Prof. Martin who is retiring as Executive Secretary of the CCU for his many contributions to the smooth running of the committee.

The date of the next meeting was set as 13-14 May 2004.

Dr J. Flowers, Rapporteur

Appendix U 1.
Working documents submitted to the CCU at its 15th meeting

Working documents submitted to the CCU at its 15th meeting are on restricted access.