Bureau International des Poids et Mesures

Consultative Committee for Amount of Substance (CCQM)

6th Meeting (April 2000)

Note on the use of the English text

To make its work more widely accessible the Comité International des Poids et Mesures publishes an English version of its reports.

Readers should note that the official record is always that of the French text. This must be used when an authoritative reference is required or when there is doubt about the interpretation of the text.

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THE BIPM AND THE METRE CONVENTION

The Bureau International des Poids et Mesures (BIPM) was set up by the Metre Convention signed in Paris on 20 May 1875 by seventeen States during the final session of the diplomatic Conference of the Metre. This Convention was amended in 1921.

The BIPM has its headquarters near Paris, in the grounds (43 520 m^2) of the Pavillon de Breteuil (Parc de Saint-Cloud) placed at its disposal by the French Government; its upkeep is financed jointly by the Member States of the Metre Convention.

The task of the BIPM is to ensure worldwide unification of physical measurements; its function is thus to:

- establish fundamental standards and scales for the measurement of the principal physical quantities and maintain the international prototypes;
- carry out comparisons of national and international standards;
- ensure the coordination of corresponding measurement techniques;
- carry out and coordinate measurements of the fundamental physical constants relevant to these activities.

The BIPM operates under the exclusive supervision of the Comité International des Poids et Mesures (CIPM) which itself comes under the authority of the Conférence Générale des Poids et Mesures (CGPM) and reports to it on the work accomplished by the BIPM.

Delegates from all Member States of the Metre Convention attend the General Conference which, at present, meets every four years. The function of these meetings is to:

- discuss and initiate the arrangements required to ensure the propagation and improvement of the International System of Units (SI), which is the modern form of the metric system;
- confirm the results of new fundamental metrological determinations and various scientific resolutions of international scope;
- take all major decisions concerning the finance, organization and development of the BIPM.

The CIPM has eighteen members each from a different State: at present, it meets every year. The officers of this committee present an annual report on

the administrative and financial position of the BIPM to the Governments of the Member States of the Metre Convention. The principal task of the CIPM is to ensure worldwide uniformity in units of measurement. It does this by direct action or by submitting proposals to the CGPM.

The activities of the BIPM, which in the beginning were limited to measurements of length and mass, and to metrological studies in relation to these quantities, have been extended to standards of measurement of electricity (1927), photometry and radiometry (1937), ionizing radiation (1960) and to time scales (1988). To this end the original laboratories, built in 1876-1878, were enlarged in 1929; new buildings were constructed in 1963-1964 for the ionizing radiation laboratories and in 1984 for the laser work. In 1988 a new building for a library and offices was opened.

Some forty-five physicists and technicians work in the BIPM laboratories. They mainly conduct metrological research, international comparisons of realizations of units and calibrations of standards. An annual report, published in the *Procès-Verbaux des Séances du Comité International des Poids et Mesures*, gives details of the work in progress.

Following the extension of the work entrusted to the BIPM in 1927, the CIPM has set up bodies, known as Consultative Committees, whose function is to provide it with information on matters that it refers to them for study and advice. These Consultative Committees, which may form temporary or permanent working groups to study special topics, are responsible for coordinating the international work carried out in their respective fields and for proposing recommendations to the CIPM concerning units.

The Consultative Committees have common regulations (*BIPM Proc.-Verb. Com. Int. Poids et Mesures*, 1963, **31**, 97). They meet at irregular intervals. The chairman of each Consultative Committee is designated by the CIPM and is normally a member of the CIPM. The members of the Consultative Committees are metrology laboratories and specialized institutes, agreed by the CIPM, which send delegates of their choice. In addition, there are individual members appointed by the CIPM, and a representative of the BIPM (Criteria for membership of Consultative Committees, *BIPM Proc.-Verb. Com. Int. Poids et Mesures*, 1996, **64**, 124). At present, there are ten such committees:

1 The Consultative Committee for Electricity and Magnetism (CCEM), new name given in 1997 to the Consultative Committee for Electricity (CCE) set up in 1927;

2 The Consultative Committee for Photometry and Radiometry (CCPR), new name given in 1971 to the Consultative Committee for Photometry (CCP) set up in 1933 (between 1930 and 1933 the CCE dealt with matters concerning photometry);

3 The Consultative Committee for Thermometry (CCT), set up in 1937;

4 The Consultative Committee for Length (CCL), new name given in 1997 to the Consultative Committee for the Definition of the Metre (CCDM), set up in 1952;

5 The Consultative Committee for Time and Frequency (CCTF), new name given in 1997 to the Consultative Committee for the Definition of the Second (CCDS) set up in 1956;

6 The Consultative Committee for Ionizing Radiation (CCRI), new name given in 1997 to the Consultative Committee for Standards of Ionizing Radiation (CCEMRI) set up in 1958 (in 1969 this committee established four sections: Section I (X- and γ-rays, electrons), Section II (Measurement of radionuclides), Section III (Neutron measurements), Section IV (α-energy standards); in 1975 this last section was dissolved and Section II was made responsible for its field of activity);

7 The Consultative Committee for Units (CCU), set up in 1964 (this committee replaced the "Commission for the System of Units" set up by the CIPM in 1954);

8 The Consultative Committee for Mass and Related Quantities (CCM), set up in 1980;

9 The Consultative Committee for Amount of Substance (CCQM), set up in 1993;

10 The Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV), set up in 1998.

The proceedings of the General Conference, the CIPM and the Consultative Committees are published by the BIPM in the following series:

- *Comptes Rendus des Séances de la Conférence Générale des Poids et Mesures;*
- *Procès-Verbaux des Séances du Comité International des Poids et Mesures;*
- *Reports of Meetings of Consultative Committees.*

The BIPM also publishes monographs on special metrological subjects and, under the title *Le Système International d'Unités (SI)*, a brochure, periodically updated, in which are collected all the decisions and recommendations concerning units.

The collection of the *Travaux et Mémoires du Bureau International des Poids et Mesures* (22 volumes published between 1881 and 1966) and the *Recueil de Travaux du Bureau International des Poids et Mesures* (11 volumes published between 1966 and 1988) ceased by a decision of the CIPM.

The scientific work of the BIPM is published in the open scientific literature and an annual list of publications appears in the *Procès-Verbaux* of the CIPM.

Since 1965 *Metrologia*, an international journal published under the auspices of the CIPM, has printed articles dealing with scientific metrology, improvements in methods of measurement, work on standards and units, as well as reports concerning the activities, decisions and recommendations of the various bodies created under the Metre Convention.

LIST OF MEMBERS OF THE CONSULTATIVE COMMITTEE FOR AMOUNT OF SUBSTANCE

as of 6 April 2000

President

Dr R. Kaarls, member of the Comité International des Poids et Mesures.

Executive secretary

Dr R.S. Davis, Bureau International des Poids et Mesures [BIPM], Sèvres.

Members

Bureau National de Métrologie: Laboratoire National d'Essais [BNM-LNE], Paris.

D.I. Mendeleyev Institute for Metrology of Gosstandart of Russia [VNIIM], St Petersburg.

Danish Institute of Fundamental Metrology [DFM], Lyngby.

Institute for Reference Materials and Measurements [IRMM], European Commission.

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

International Organization for Standardization: Committee on Reference Materials [ISO-REMCO].

International Union of Pure and Applied Chemistry [IUPAC].

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

National Institute of Metrology [NIM]/National Research Centre for Certified Reference Materials [NRCCRM], Beijing.

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

National Physical Laboratory [NPL]/Laboratory of the Government Chemist [LGC], Teddington.

National Research Council of Canada [NRC], Ottawa.

National Research Laboratory of Metrology [NRLM]/National Institute of Material and Chemical Research [NIMC], Tsukuba.

Nederlands Meetinstituut: Van Swinden Laboratorium [NMi-VSL], Delft.

Physikalisch-Technische Bundesanstalt [PTB]/Bundesanstalt für Materialforschung und -prüfung [BAM], Braunschweig and Berlin.

Swedish National Testing and Research Institute [SP], Borås.

The Director of the Bureau International des Poids et Mesures [BIPM], Sèvres.

Observers

Central Office of Measures [GUM], Warsaw.

CSIRO, National Measurement Laboratory [CSIRO-NML], Lindfield.

National Office of Measures [OMH], Budapest.

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

Office Fédéral de Métrologie [OFMET], Wabern.

Slovenský Metrologický Ústav [SMU], Bratislava.

Consultative Committee for Amount of Substance

Report of the 6th Meeting

(6 - 7 April 2000)

Agenda

1 Opening of the meeting; agenda; appointment of a rapporteur.

2 Report of the fifth meeting.

3 The Mutual Recognition Arrangement and the present status of the BIPM key comparison database for chemistry.

4 Discussion of Appendix C of the Mutual Recognition Arrangement.

5 Reports of working groups:

5.1 Organic analysis;

5.2 Inorganic analysis;

5.3 Gas analysis;

5.4 Electrochemical analysis (including pH);

5.5 Surface analysis (proposal);

5.6 Key comparisons.

5 Primary methods.

6 Workshop on uncertainty, December 1999 (follow-up).

7 Metrology in biotechnology.

8 The BIPM programme of metrology in chemistry.

10 Other business.

11 Date of next meeting.

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

The Consultative Committee for Amount of Substance (CCQM) held its sixth meeting at the Bureau International des Poids et Mesures (BIPM), at Sèvres, on 6 and 7 April 2000.

The following were present: K. Carneiro (DFM), T. Catterick (LGC), P. De Bièvre (IRMM/ISO-REMCO), E.W.B. de Leer (NMi-VSL), G. Dube (PTB), R. Dybkaer (IFCC), A. Fajgelj (IUPAC/IAEA), W. Hässelbarth (BAM), Euijin Hwang (KRISS), H. Jancke (BAM), R. Kaarls (President), M. Kurahashi (NIMC), J. McLaren (NRC), A. Marschal (BNM-LNE), W.E. May (NIST), B. Milman (VNIIM), M.J.T. Milton (NPL), K. Okamoto (NIMC), U. Örnemark (SP), T.J. Quinn (Director of the BIPM), W. Richter (PTB), M. Sargent (LGC), H.G. Semerjian (NIST), Hun-Young So (KRISS), C. Takahashi (NRLM), P. Taylor (IRMM), Min Zhao (NRCCRM).

Observers: L. Besley (CSIRO), E. Deák (OMH), H. Felber (OFMET/ EMPA), H.-P. Haerri (OFMET), B. King (CSIRO/NARL), W. Kozlowski (GUM), K. Lal (NPLI), M. Máriássy (SMU).

Invited: A. Botha (CSIR), R.R. Greenberg (NIST), M.T. López Esteban (CEM), Y. Mitani (CENAM), A. Nomura (APMP), I. Papadakis (IRMM), M. Plassa (IMGC-CNR), A. Squirrell (CITAC).

Also present: P. Giacomo (Director emeritus of the BIPM); R.S. Davis, C. Thomas, R. Wielgosz (BIPM).

Excused: M. Grasserbauer (IRMM), Yu. Koustikov (VNIIM), P. Woods (NPL), Yadong Yu (NRCCRM).

Absent: NIM.

The President opened the meeting and welcomed the participants. He introduced two new delegates: Dr René Dybkaer, representing the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) and Dr Ales Fajgelj, representing the International Atomic Energy Agency (IAEA), as well as the International Union of Pure and Applied Chemistry (IUPAC). He also welcomed Dr Robert Wielgosz, the newly selected Head of the BIPM Chemistry Section. He noted that the continued high attendance at this meeting, and at meetings of the various working groups earlier in the week, signal continuing progress of, and growing interest in, the activities of the CCQM.

The President reported that the draft resolutions on metrology in chemistry and on metrology in biotechnology discussed at last year's meeting had been approved by the CGPM at its October 1999 meeting as Resolutions 10 and 11 respectively. He also reported that a supplementary draft resolution presented by the CIPM to the CGPM regarding the adoption of the derived unit "katal", to denote mol/s when expressing enzyme catalytic activity, had been approved with minor modification at the same meeting as Resolution 12.

The Director of the BIPM, Dr Quinn, added his own words of welcome.

Dr McLaren was appointed Rapporteur, to be assisted by Dr Davis and Dr Wielgosz.

The agenda was adopted without modification.

2 REPORT OF THE FIFTH MEETING

The report of the fifth meeting, as distributed to the delegates, were accepted without further changes.

3 THE MUTUAL RECOGNITION ARRANGEMENT AND THE PRESENT STATUS OF THE BIPM KEY COMPARISON DATABASE FOR CHEMISTRY

The President reviewed recent developments regarding the Mutual Recognition Arrangement (MRA) and its associated databases since the signing of the MRA by directors of the national metrology institutes (NMIs) in October 1999. He reported that, at a meeting of the Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB) in March 2000, it was agreed that Appendix B (the BIPM key comparison database) will contain results of all CIPM and regional metrology organizations (RMOs) key comparisons (KCs) and supplementary comparisons (SCs). It was also

unanimously agreed that calibration and measurement capabilities (CMCs) must be declared fully reliable by the RMOs before they are entered into Appendix C (the CMC database). Furthermore, it was declared that, in the absence of a sufficient number of key comparisons and/or supplementary comparisons, the best use should be made of all available relevant information (e.g. other bilateral or multilateral comparisons, peer-reviewed measurement activities, etc.) for this purpose. The process for acceptance of CMCs for Appendix C was reviewed to remind delegates that CMC claims are first reviewed by their own RMO, then by the other RMOs, prior to final review by the JCRB.

The President also reported that, in the case of amount-of-substance measurements, the JCRB had taken the decision that the initial content of Appendix C will be restricted to gas metrology. CMCs for gas metrology will be reviewed by the JCRB at its March 2001 meeting, in anticipation of publication of the first approved Appendix C claims for chemistry in the BIPM key comparison database by May 2001. CMCs for other areas of chemical metrology are tentatively scheduled for review by the JCRB at its October 2001 meeting. In the meantime, CMC claims can proceed through the two stages of RMO review so as to be ready for the JCRB review next year.

Dr Claudine Thomas of the BIPM then made a presentation on the content and format of Appendix B. For illustrative purposes, she used data from the already completed series of gas metrology key comparisons, CCQM-K1 (a-g), that had been prepared in collaboration with the Working Group on Gas Analysis. She noted that these data had not yet been entered into Appendix B. Her presentation clearly illustrated that the Appendix will allow for both tabular and graphical presentation of the key comparison data. In addition, the content will include a statement about how the key comparison reference value (KCRV) was defined, a statement about the degree of equivalence of each laboratory's value with the KCRV, and statements about the degree of equivalence between laboratories. She noted that it was up to the working group to decide how to determine a KCRV and degrees of equivalence. Hard copies of the Appendix B data presentation for CCQM-K1.a (CO in nitrogen at 100 μmol/mol) were distributed to delegates as document CCQM/00-8.

Dr de Leer initiated discussion by complimenting the BIPM, on behalf of the Working Group on Gas Analysis, for its excellent cooperation with the working group in the preparation of this presentation. Dr Quinn and Dr Thomas responded that it was their wish that a similar format be followed

for key comparisons in other areas of chemical metrology. Much of the subsequent discussion was centred on whether or not it is always necessary to determine a KCRV. Dr De Bièvre reminded delegates of the discussion paper (CCQM/99-03) he submitted to last year's meeting, in which he recommended the use of a "reference range", as opposed to a reference value. He again pointed out that this was a matter of principle, which was consistent with modern "uncertainty" thinking (*Guide to the expression of uncertainty in measurement*, GUM). As long as this "range" was small enough in comparison with the spread in the field, it should be fulfilling its metrological function. Dr Semerjian expressed the opinion that the decision whether or not to identify a KCRV should be left to the discretion of the working group, in consultation with the CCQM. Dr May supported this for the particular case of key comparisons involving determination of trace constituents in complex matrices. For these types of key comparisons, reference values are not known gravimetrically; in addition, the non-homogeneity of a complex sample can make a substantial contribution to the uncertainty of the reference value. Dr Quinn agreed that, in the case of CCQM-K1, determination of KCRVs from the submitted results was unnecessary because these values were known gravimetrically in advance. These gravimetrically determined values *de facto* replace a KCRV calculated on the basis of values submitted by the participating laboratories. Dr Quinn was of the opinion that in general it was both possible and desirable to derive a KCRV, and he cited the text of the MRA.

There was also considerable discussion of the details of how a KCRV should be determined. Whilst there was a divergence of opinion on some details, it was generally agreed that the handling of the results should involve a judicious combination of chemical knowledge and statistics. Dr Hässelbarth in particular recommended against an approach entirely driven by statistics, e.g. establishing a KCRV as the simple or weighted mean of individual values. Dr de Leer asked for clarification of the approval process for the method of establishing a KCRV. The President responded that it is the responsibility of the working group to bring forward its recommendations to the CCQM. Dr Quinn confirmed that it is the responsibility of the CCQM to approve the recommendations of the working group, but recognized that better documentation of the process would be desirable.

4 DISCUSSION OF APPENDIX C OF THE MUTUAL RECOGNITION ARRANGEMENT

The President reported that the exact format for listing of CMCs in chemical metrology is still under review, but showed a draft template which had been reviewed by the JCRB at its last meeting. The template allows two types of services to be listed: measurement capability and certified reference materials (CRMs). In either case the listings would be organized according to measurand classes, or individual measurands in a particular matrix type, such as cholesterol in human serum for example. In the case of measurement services, the table would also indicate the range of measurement capability and its associated uncertainty. In the case of CRMs, the table would indicate the range of certified values and associated uncertainties. Another column of the table would allow the NMI to identify its mechanism(s) for measurement service delivery; in the case of an NMI which produces CRMs, the CRM number would be listed in this column. All of the information described above would be accessible to the public, but another section of the Appendix C table, not accessible to the public, would contain additional information such as the basis for traceability, measurement techniques used, link(s) to Appendix B, and any additional NMI comments.

The Appendix C template stimulated considerable discussion. Dr King asked whether any thought had been given to including information about an NMI's quality system and/or accreditation status. The President responded that this information is not required in Appendix C, since it is reviewed by the RMO prior to submission of the CMCs to the JCRB. Dr Carneiro confirmed that the EUROMET review of the quality system documentation of European participants in the MRA will begin in the fall of 2000. The President noted that the issue of the assessment of the quality system, eventually in the form of a formal accreditation, was a contentious one between the RMOs and would be discussed again at the October 2000 JCRB meeting. Dr Quinn reminded the committee that the MRA allows for demonstration of quality of calibration and measurement services without formal accreditation, as defined in Section 7.3b. He also pointed out that there is not a one-to-one relationship between Appendix C claims and any accreditation programme.

A number of minor revisions to the template were proposed. Dr De Bièvre recommended that the column heading "Expansion factor" be changed to "Coverage factor" to be consistent with the GUM. Dr Richter, noting that some of the measurement services in Appendix C will be provided by

laboratories other than NMIs, asked whether "NMI" was the appropriate heading for the second column. The President indicated that, even if the measurement capability in a given country is "distributed" between several laboratories, only one laboratory per country (the NMI officially designated by its government) is the signatory to the MRA. Dr Semerjian nevertheless felt that the service provider ought to be identified if it was a laboratory other than the NMI. Whilst agreeing to take these recommended changes back to the CIPM, the President asked for, and was given CCQM approval of the basic format of the proposed template. He agreed with a suggestion by Dr Marschal that it would be advisable to provide NMIs with a guide for making entries into the amount-of-substance CMCs, in order to ensure consistency of the Appendix C content.

5 REPORTS OF WORKING GROUPS

5.1 Organic analysis

Dr May presented a summary of the results of the 1999/2000 activities of the Working Group on Organic Analysis and a proposed plan of future activities prepared at a meeting of the group earlier in the week. Prior to presenting this summary, he outlined some general guidelines, agreed to by the group, regarding participation in pilot studies and key comparisons, and determination of KCRVs.

The working group decided that where a key comparison existed that had been preceded by a pilot study, only those participants who had previously taken part in the pilot study would be eligible to have their key comparison results used in the calculation of a KCRV. This would not prevent new participants joining the key comparison, or having their degree of their measurement equivalence calculated, nor would it mean that all the results, from laboratories which had taken part in both the pilot study and the key comparison, would necessarily be included in the determination of the KCRV.

CCQM-K5 was a key comparison on the determination of the mass fraction of pp'-DDE in a fish oil matrix by isotope dilution mass spectrometry. Each laboratory was sent two samples containing the compound at natural and

fortified mass fractions within the range 1 μg/g – 10 μg/g prepared by the pilot laboratory (LGC); the fortified sample was prepared by gravimetric addition of pp'-DDE in 2,2,4-trimethylpentane to the oil. Ten sets of results were received from NMIs of nine countries (both the BAM and PTB participated). Simple means of the results at each of the two mass fractions displayed a coefficient of variation (the dispersion of results relative to the mean value) of approximately 2.5 %. No KCRV was determined. There were some inconsistencies in the type B evaluation of uncertainty. The results of one laboratory appeared to be biased on the high side for both samples; it was felt that this bias might be related to the purity of calibration materials. A Draft B report is being prepared for distribution to the CCQM.

CCQM-K6 was a key comparison on the determination of the mass fraction of cholesterol in frozen human serum by isotope dilution mass spectroscopy (IDMS). Each laboratory was sent three discrete aliquots of each of two samples, both containing cholesterol at natural levels in the range from 1.5 mg/g to 2.5 mg/g. Results were received from six NMIs, five of which had participated in a previous pilot study. Simple means of the results at each of the two concentrations displayed a coefficient of variation of approximately 1 %. No KCRV was determined. Uncertainty budgets were more consistent than was the case in CCQM-K5. A Draft B report is being prepared for distribution to the CCQM.

The results of several pilot studies completed in 1999 were also summarized. CCQM-P3.2 was a second investigation of the performance of NMR spectroscopy as a candidate primary ratio method for measuring the concentrations of organic compounds in liquid mixtures. The pilot laboratory was the BAM. The test sample was a gravimetrically prepared mixture of five organic compounds in benzene-D6. The measured amount fraction of each compound to the total amount of solute compounds was as follows: 1,2,4,5-tetramethylbenzene, 942.7 mmol/mol; ethyl 4-toluene sulfonate, 18.0 mmol/mol; cyclododecane, 10.9 mmol/mol; octamethylcyclo-tetra-siloxane, 15.8 mmol/mol; [2,2]-paracyclophane, 12.7 mmol/mol. Laborator-ies (not all of them NMIs) from ten countries participated in the study. Most of the values submitted agreed to within ± 2 % of the gravimetric values.

Pilot studies were conducted for the determination of gamma-HCH (CCQM-P10) and pp'-DDT (CCQM-P21) by IDMS in a fish oil. The fish oil sample was the same as that used for CCQM-K5. As was the case for CCQM-K5, each laboratory was sent two samples containing the measurands at natural and fortified mass fractions. Levels of gamma-HCH in the unspiked oil were very low (about 20 ng/g), with the result that the coefficient of

variation of the mean was about 60 %. The working group recommended that this study be repeated with a sample containing the compound at a mass fraction of at least 50 ng/g to 100 ng/g. The other study was more successful, with good agreement between the participating laboratories at natural and fortified levels of 0.3 μg/g and 4.7 μg/g, respectively. The working group recommended proceeding to a key comparison.

The status of several previously planned pilot studies was briefly reviewed. CCQM-P8 (glucose in human serum) is under way. Two frozen serum samples plus a sample of NIST SRM 917a glucose were sent by the pilot laboratory (NIST) to five other NMIs in February 2000; results are due 31 July 2000. No particular method is prescribed.

CCQM-P9 (creatinine in serum) is also under way. Two lyophilized materials plus a sample of NIST SRM 914a were sent by the pilot laboratory (NIST) to six other NMIs in February 2000; results are due 31 July 2000. No particular method is prescribed.

CCQM-P17 (PCBs in marine sediment) will commence in June 2000, with the NIST and NRC as joint pilot laboratories. Samples will be sent to participating laboratories in June 2000, with results due by 30 November 2000. Four PCB congeners (IUPAC Nos 28, 101, 153 and 170) have been proposed as the measurands. No particular method is prescribed.

CCQM-P18 (tributyltin, TBT, in marine sediment) will commence when a suitable sample material has been identified and homogeneity testing has been completed by the pilot laboratory (NRC). The approximate value for the TBT mass fraction is 50 ng/g-100 ng/g (as Sn). Reference compounds and internal standards are to be provided where possible, although laboratories will be asked to use both the standards provided and their own.

One new pilot study (CCQM-P27), the determination of LSD at the 1 ng/ml-5 ng/ml level in urine, was proposed, with the LGC as the pilot laboratory.

The status of all key comparisons and pilot studies of the Working Group on Organic Analysis, completed, in progress or planned for 2000, is summarized in Table 1 (see on page 84). Also shown in the table are a number of comparisons not expected to start until 2001.

5.2 Inorganic analysis

Dr Sargent presented a summary of the results of the 1999/2000 activities of the Working Group on Inorganic Analysis and a proposed plan of future activities prepared at a meeting of the group earlier in the week.

CCQM-K2 was a key comparison on the determination of the content of Cd and Pb (in the range 0.05 nmol/g to 0.1 nmol/g) in a natural fresh water sample by IDMS; the pilot laboratory was the IRMM, which also distributed identical samples for the IMEP-9 comparison. Measurements were completed in December 1998; although the results from nine NMIs agreed within the target range, it was clear that there were inconsistencies in the reporting of uncertainties. Most of these were resolved at a working group meeting in December 1999, at which time a version of the Draft B report was also discussed. KCRVs based on the unweighted means of the individual values (after exclusion of one result for Pb) are proposed in a report to be submitted to *Metrologia* in May 2000. The key comparison was approved for equivalence by the CCQM, and the results will be entered into the database.

CCQM-K8 was a key comparison on the determination of Al, Cu, Fe and Mg at 1 g/kg mass fraction in single element calibration solutions in dilute acid. Solutions prepared by the pilot laboratory (EMPA) were analysed by a variety of methods (including titrimetry, coulometry, gravimetric analysis, ICP-OES and IDMS) in twelve NMIs. Almost all results were well within ± 0.5 % of the gravimetrically determined reference values, although uncertainties varied considerably, depending on the method and the laboratory. A Draft A report was reviewed and approved by the working group in April 2000; a Draft B report is being prepared.

CCQM-P7 is an ongoing study, piloted by the NIST, intended to compare various approaches to determining the purity of inorganic substances. Samples of NaCl, KCl and $K_2Cr_2O_7$ were sent at the end of September 1998 to thirteen laboratories. By the end of January 1999, fifteen sets of results had been received. The methods used for analysis were coulometry, gravimetry, potentiometric titration, and summation of impurities determined by instrumental analysis (e.g. ICP-MS). The results indicated that the methods often gave different results, and that the most appropriate method for a particular compound depends on its intended use. No new measurements have been made since then, but the results were discussed in more detail at a working group meeting in December 1999. It was recommended that a combination of methods is often needed in order to fully characterize purity.

CCQM-P15 was a pilot study on the determination of the content of Cd and Pb at natural levels (approximately 23 nmol/g and 420 nmol/g, respectively) in a marine sediment; the pilot laboratory was the IRMM. Samples of the material were analysed by nine NMIs. The same material was analysed by a much larger number of laboratories participating in the IMEP-14 programme. Results for Cd from eight NMIs displayed a coefficient of variation of about 2.5 %. After the withdrawal of one laboratory's result, the coefficient of variation for Pb results was similar. Some discrepancies in uncertainty estimates were noted; in part, these were believed to arise from the inclusion by some laboratories, but not others, of a term in the budget related to the possibility of incomplete dissolution. A draft report was reviewed at the April 2000 working group meeting. It was recommended that this study be followed up with a similar key comparison.

CCQM-P19 is a pilot study on the assay of a high-purity HCl solution, piloted by the NIST. Twelve participating laboratories will determine the content of one or more of the following constituents: hydrogen ions; chloride; and impurities (especially bromide). This study is of relevance to high-accuracy pH determinations.

Dr Sargent then briefly reviewed the status of several pilot studies previously proposed by the working group, and now expected to commence in 2000.

CCQM-P11 is a study on the determination of As in either a frozen fish material or a freeze-dried shellfish material. The pilot laboratory (NIST) is to circulate a draft protocol by June 2000, in anticipation of results being received by December 2000. Participants would be free to use the method of their choice. This study is considered to be an important test of the degree of equivalence of NMIs in the determination of a monoisotopic element in a complex matrix of importance to health, the environment and food safety.

CCQM-P12 is a study on the determination of Pb (and possibly also Pb isotope ratios) in wine. The pilot laboratory (IRMM) expects to circulate a draft protocol by May 2000. The sample is ready for distribution, and the proposed deadline for results is November 2000. This study would expand the scope of previous IDMS studies and comparisons involving determination of Pb to a complex liquid organic matrix, and would address both trade and food safety issues. The same material is also to be used in the IMEP programme.

CCQM-P13 is study on the determination of three elements (Ca, Cu and Cd) in a synthetic food digest by IDMS. The pilot laboratory (LGC) expects to circulate a draft protocol by May 2000. Samples will be ready for distribution

in October 2000, with a proposed deadline of February/March 2001 for results. Because the sample would be a synthetic solution, gravimetric reference values would be available.

The status of all inorganic analysis working group key comparisons and pilot studies completed, in progress, or planned for 2000, is summarized in Table 1. Also shown in the table are a number of comparisons not expected to start until 2001.

Dr Sargent also presented suggested templates to be used to propose CCQM pilot studies or key comparisons. Dr Taylor (IRMM) had prepared these templates by adaptation of forms used by EUROMET. Amongst the information to be supplied on these forms were the title of the pilot study or key comparison, the name of the proposing institute, rationale and scope of the comparison, brief description and proposed starting date and time scale. He recommended that all of the CCQM working groups adopt a common format to facilitate communication about forthcoming comparisons. It was agreed that the formats will be developed and sent around to the working group chairmen for comments.

5.3 Gas analysis

Dr de Leer presented a summary of the results of the 1999/2000 activities of the Working Group on Gas Analysis and a proposed plan of future activities prepared at a meeting of the group earlier in the week.

CCQM-K3 was a key comparison on the determination of amount-of-susbtance fraction of "automotive emission" gases CO, CO_2 and C_3H_8 in nitrogen, at nominal levels of 32 mmol/mol, 135 mmol/mol and 2.05 mmol/mol, respectively, in gas cylinders prepared gravimetrically by the pilot laboratory (NMi). Cylinders were shipped in July/August 1998, and results from thirteen laboratories in twelve countries had been received by May 1999. Most laboratories used gas chromatography for the analyses; two laboratories used non-dispersive IR spectroscopy. In most cases the measurement method utilized primary binary gas mixture standards, whereas in one laboratory an "exact matching" method of the four gas components, using a dynamic blending technique, was employed. Results for all three gases agreed within ± 1 % of the gravimetric values. A Draft B report (provided to delegates as document CCQM/00-7) has been reviewed and approved by the working group. The key comparison was approved for equivalence by the CCQM, and the results will be entered into the database.

CCQM-K4, a key comparison on the determination of ethanol in air at 120 µmol/mol, was begun last year. The results received indicated satisfactory agreement between laboratories, with most participants falling within a band of ± 1 % of the reference value defined by the gravimetric values from the pilot laboratory (NPL). The key comparison was approved for equivalence by the CCQM, and the results will be entered into the database.

Dr de Leer reported that the APMP, EUROMET and SIM regional key comparisons on automotive emissions gases and ethanol in air would be carried out in 2000.

CCQM-K7 is a key comparison on the determination of benzene, toluene and xylene (at amount fractions less than 50 nmol/mol) in air. Some technical problems were encountered during the comparison, but in the opinion of the working group these were not severe enough to invalidate it. The pilot laboratory (NIST) is preparing Draft A of the report.

Dr de Leer also reported some other activities planned for 2000. A study (CCQM-P24) intended to validate dynamic methods for the preparation of primary gas mixtures is to be carried out, with the BNM-LNE as the pilot laboratory (document CCQM/00-1). Delegates were invited to indicate their interest in taking part in this study. Suggestions for amendments to the proposal project were welcomed, and were to be sent to the author (A. Marschal, BNM-LNE) before 31 December 2000. A workshop on air quality (in particular, ozone) measurements, jointly sponsored by the NIST and NPL, is also planned.

The status of all gas analysis working group key comparisons and pilot studies completed, in progress, or planned for 2000, is summarized in Table 1. Also shown in the table are a number of comparisons not expected to start until 2001 or later. These include key comparisons on the determination of CO_2 and CH_4 at ambient levels in air (CCQM-K14), on the determination of SF_6 and CFCs at emission levels in air (CCQM-K15), and on the determination of natural gas mixtures to include alkanes heavier than C_4 (CCQM-K16).

The President thanked Dr de Leer for agreeing to step in as chairman of the Working Group on Gas Analysis on short notice after the departure of Dr Alink. On behalf of the CCQM, Dr Semerjian offered congratulations to the group for being the first to have data ready for Appendix B of the MRA database. The CCQM appointed Dr de Leer as the chairman of the Working Group on Gas Analysis.

5.4 Electrochemical analysis (including pH)

Dr Richter began his report of the activities of the Working Group on pH with a proposal that the CCQM approve an extension of the scope of this group. The overall objective of an expanded mandate would be to establish the degree of equivalence of national measurement standards for pH, electrolytic conductivity and coulometric measurements. Dr de Leer supported this proposal, but asked whether other areas of electrochemistry (e.g. ion selective electrodes) could be included. Dr May advised against any tendency to restrict key comparisons to a particular technique. The CCQM approved the broadening of the scope of the group.

Dr Richter then reported results of CCQM-K9, a key comparison involving pH determinations in two phosphate buffer mixtures. The first exercise was the measurement of pH in a Na_2HPO_4/KH_2PO_4 buffer solution at a molality of 0.025 mol/kg. The second exercise was the measurement of pH of a phosphate buffer solution of unknown composition. This exercise was piloted by the PTB with ten institutes participating in total. Calculation of a KCRV for the buffer of unknown pH was complicated by two apparently outlying results. One of these was eliminated after discovery of an error in the calculation. It was agreed that the other laboratory could withdraw its results if so desired, as there was evidence that the sample may have been compromised during shipment. Future comparisons of pH measurement are expected to encompass phthalate, carbonate, borate and tetroxalate buffer systems.

There followed a general discussion on the question of withdrawing results. The CCQM confirmed its position that the Guidelines for CIPM key comparisons must be strictly followed in this respect.

A proposal to conduct a pilot comparison (CCQM-P22) of primary measurement devices for electrolytic conductivity as an extension of EUROMET 381, with the DFM as the pilot laboratory, was approved.

The status of all electrochemical analysis working group key comparisons and pilot studies completed, in progress, or planned for 2000, is summarized in Table 1. Also shown in the table are a number of comparisons not expected to start until 2001 or later.

5.5 Surface analysis (proposal)

The President drew the attention of the delegates to a proposal from the NPL (document CCQM/00-4) that the CCQM establish an *ad hoc* working group

to carry out a pilot study to demonstrate the benefit of a larger programme of comparisons between NMIs performing surface analysis measurements. He invited Dr Milton to present this proposal.

Dr Milton introduced the topic by pointing out that many advanced industries (particularly in the area of nanotechnology) depend upon accurate and traceable surface analysis measurements, and that these measurements are made with a wide range of modern instrumental methods. A number of expressions of the amount of substance at a surface are commonly used, ranging from surface molar density (expressed in mol/m^2) to the thickness of a surface layer. Although there have been comparisons of surface analysis measurements, particularly under the VAMAS agreement, none of them have been focused on establishing the degree of equivalence between laboratories or whether the results are traceable to the SI.

The proposed pilot study would involve measurements on thin layers of SiO_2 by a variety of surface analytical techniques (e.g. XPS, ARXPS, RBS, TEM) which are available in some NMIs. The objectives would be to clarify the traceability of such measurements, to establish the degree of equivalence of national measurement standards, and to raise awareness amongst a broader user population of the need for traceability. The pilot laboratory (NPL) would initiate discussions with other NMIs, and would prepare batches of SiO_2 which would be tested for homogeneity prior to distribution.

On behalf of their NMIs, Dr Hässelbarth (BAM), Dr Okamoto (NIMC) and Dr So (KRISS) expressed interest in taking part in this pilot study, in which the NPL will take the initiative. Dr Wielgosz commented on the importance of accurate measurements of surface oxide on silicon for the determination of the Avogadro constant.

The President agreed that since there was interest from a group of NMIs in participating in this study, an *ad hoc* working group should be formed. The NPL will provide a chairman for the group, which will report to the CCQM at its next meeting.

5.6 Key comparisons

Dr Semerjian presented an update of the state of CCQM key comparisons and pilot studies, summarized in Table 1 of this report (see on page 84). The key comparisons CCQM-K2, CCQM-K3 and CCQM-K4 were all approved for equivalence by the CCQM, and their results will be entered into the BIPM key comparison database.

The President reminded delegates that the normal process for announcing regional key comparisons to the appropriate Consultative Committee (CC) was by routing through the CC working group. Regional supplementary comparisons should also be made known to the CC by the same procedure. Dr Quinn expanded on this point, noting that an RMO does not require the permission of a CC to execute a regional key comparison that replicates a CC key comparison. All new key comparisons are decided by the CC, but that this can be on a proposal from an RMO.

Dr Semerjian took the opportunity to present developments concerning Appendix C submissions. He reported that the JCRB had recommended that each CC establish a list of services for each SI unit in order to provide a framework for submission of Appendix C data in a uniform and consistent manner. He then presented a proposed list of services for amount-of-substance measurements (distributed to delegates as document CCQM/00-9). The list was not intended to be comprehensive, but rather to illustrate the proposed approach to the listing of measurement services in Appendix C. This listing was consistent with the proposed Appendix C template. Measurement services were arranged by matrix type (e.g. high purity chemicals, inorganic solutions, gases, waters, biological tissues and fluids, fuels, etc.) under each of which appeared a list of measurand classes and/or measurands.

There was considerable discussion of possible alternatives to the proposed template. Some delegates preferred a simpler system with fewer, but broader, categories (e.g. pure materials, calibration mixtures, reference materials). Dr Marschal and Dr Hässelbarth both suggested that the classification system employed in the COMAR database of reference materials be examined. This database is currently under revision, which led to a suggestion that the CCQM coordinate with the ISO-REMCO in order to arrive at a common system which could be used for both Appendix C and the COMAR database. Dr Fajgelj suggested that the CCQM list be submitted to the ISO-REMCO for discussion at its next meeting, on 16-17 May 2000. Speaking on behalf of the ISO-REMCO, Dr De Bièvre indicated that it was working on the same problem and that a common approach should be realized. He strongly advocated a harmonized process. Dr Fajgelj issued an invitation to the CCQM on behalf of the IUPAC to participate in an IUPAC working group on harmonization.

6 PRIMARY METHODS

The President invited comments from the delegates to the symposium on primary methods held earlier in the week, during which presentations were given on a number of techniques (e.g. ICP-AES, INAA).

Dr Quinn expressed the view that a convincing argument had been made for the designation of INAA as having the potential to be a primary method under some conditions. He also noted the rapidly diminishing levels of financial support for the relatively few facilities worldwide at which radionuclear analyses of the highest metrological quality can be performed. He suggested that the CCQM make a formal statement of support for the continued funding of these facilities in its report of this meeting. Some delegates expressed concerns about such a formal declaration of support for a particular method. In the discussion that followed, there was no unanimous support within the CCQM for a statement designating any particular methods as primary, although it was accepted that there are many methods having the potential to be primary. The CCQM nonetheless recommended that proponents of nuclear analytical methods publish results to support claims that these techniques have the potential to provide results of the highest metrological quality.

The CCQM decided to organize a second symposium on primary methods, with much more emphasis on the question “How far does the light shine?” This phrase describes the challenge that the CCQM faces in identifying, designing and conducting a limited number of key comparisons to enable the assessment of measurement comparability among national metrology institutes across the entire field of chemistry.

The President then asked for suggested topics for future symposia on primary methods. Dr Marschal proposed the theme “Primary Methods – How Do They Transfer?” Dr Papadakis suggested the theme “Dissemination Mechanisms”.

7 WORKSHOP ON UNCERTAINTY, DECEMBER 1999 (FOLLOW-UP)

The President invited Dr S. Ellison (LGC) to comment on the report of an *ad hoc* working group (comprising Dr S. Ellison, Dr K. Eberhardt of the NIST, and Dr C. Thomas of the BIPM) formed in December 1999 to follow up on some issues which were raised during the CCQM uncertainty workshop. Specifically, the working group was asked to make recommendations regarding the determination of KCRVs, of the uncertainties associated with KCRVs, and of the uncertainties associated with equivalence statements. The working group developed recommendations to cover three broad scenarios with respect to the uncertainty statements provided by the participants in a key comparison: visibly underestimated uncertainties; apparently realistic uncertainties; and apparently overestimated uncertainties. Their recommendations are outlined in document CCQM/00-6. Dr Ellison ended his presentation with a request for advice from the CCQM as to whether further work needed to be done.

Dr Milton suggested that including references to some very helpful relevant publications could strengthen the report. Dr Quinn expressed the opinion that the experience of the CCQM to date does not suggest the need for a statistical treatment more sophisticated than has been provided. Dr May suggested that the CCQM needs statistical advice on how to take into account the uncertainty of the KCRV arising from sample inhomogeneity. This is particularly important in the case of a key comparison involving the determination of one or more trace constituents in a complex matrix sample. Dr De Bièvre cited this difficulty as a justification for his recommendation to define a “reference range” rather than a KCRV, in such key comparisons. Dr Hässelbarth did not completely agree, noting that KCRVs are obviously needed if degrees of equivalence are to be calculated. He did agree with Dr May that, as a means of deciding how to account for any residual bias, it would be helpful to have an objective method for the examination of the results of a key comparison on a complex sample to establish what part of the total uncertainty of the KCRV can be accounted for by the stated uncertainties of the participants. In response to this, Dr May suggested that homogeneity data be acquired for one or more complex samples from completed key comparisons or pilot studies, as a stimulus to further discussion.

In conclusion, Dr Ellison asked the delegates to provide him with examples of any methods other than the ones described in CCQM/00-6 that had been used in determining the uncertainty of KCRV values in any of the CCQM key comparisons completed to date.

The President thanked Dr Ellison for his important contribution to the work of the CCQM in particular with respect to the issue of measurement uncertainty.

8 METROLOGY IN BIOTECHNOLOGY

Dr Sargent opened the discussion of metrology in biotechnology with a brief overview (based on document CCQM/00-3) of the types of measurements made in biological systems, and of issues in the development of metrology in this area which might be addressed by the CCQM. For the purposes of this overview, biotechnology was subdivided into four areas: cell biology; biochemistry; protein chemistry; and molecular biology. Specialized measurement methodology is applied in each of these areas (e.g. the polymerase chain reaction amplification of DNA) in addition to the more general use of a wide range of common physico-chemical measurement methods (e.g. NMR, fluorescence spectroscopy, mass spectrometry, liquid chromatography, electrophoresis). Given the breadth of measurements in biological systems, it would be possible for the CCQM to play an active role in only a few strategically selected areas. As a first step in this selection process, Dr Sargent proposed a one-year study by an *ad hoc* working group of interested CCQM delegates and other stakeholders. He emphasized that an international metrology programme in this field is justifiable only if it brings about improvement in the reliability and comparability of routine measurements.

Dr Sargent's introduction was followed by presentations by Dr H. Parkes (LGC) and Dr D. Reeder (NIST). Dr Parkes' lecture "Metrology issues in analytical molecular biology" placed emphasis on DNA analysis. She reported that nucleic acid measurement is still an immature and rapidly evolving technology, and emphasized that issues of accuracy are just as significant for qualitative DNA analysis as for quantitative DNA analysis. She also noted that there is at present only a limited measurement

infrastructure, with requirements for a metrology framework, reference materials and quality assurance schemes. Dr Reeder reviewed the NIST activities intended to ensure high standards of DNA testing, including DNA fingerprinting for forensic purposes. These activities include the production of a number of standard reference materials (SRMs) for DNA profiling, participation in a technical working group on DNA analytical methods, and support of accreditation and certification programmes for DNA testing laboratories. He also reported that the NIST had coordinated some international comparisons on DNA quantification (at levels of 0.5 ng/l – 5 ng/l), and was active in the development of a time-of-flight mass spectrometer detection system (with pulsed laser ionization of samples) which promises 10-100 times better resolution than capillary electrophoresis systems. In describing measurement instrumentation in this field he acknowledged that the majority of instruments were based upon fluorescence measurements, and here there was an immediate requirement for fluorescence transfer standards.

These presentations stimulated a lively round of discussion and questions. Dr Wielgosz asked the speakers about the heavy patent protection of DNA amplification and measurement methodologies, and what impact this would have on the development of metrology in this field, considering that 80 % of the market was controlled by one manufacturer. Dr Parkes acknowledged that heavy patent protection does make some types of measurements more expensive than they would otherwise be. Dr Reeder replied that he had recently been invited to visit the major instrument manufacturers to discuss traceability and calibration issues, including NIST reference materials. Dr Richter asked whether the rate of change in biotechnology was likely to decrease in the foreseeable future. Dr Catterick noted that the fact that forensic DNA databases are being established suggests that methodologies have stabilized to some extent, to which Dr Reeder agreed. The discussion concluded with an agreement to establish an *ad hoc* working group, as proposed by the LGC, with representation from the IFCC, LGC and the NIST. Dr De Bièvre, Dr de Leer and Dr So also expressed interest in participation. It was suggested that this group be led by Dr Parkes.

9 THE BIPM PROGRAMME OF METROLOGY IN CHEMISTRY

Dr Quinn presented a broad outline of the planned BIPM programme of metrology in chemistry, in which the emphasis will be on gas metrology. The programme will be developed in consultation with an advisory group of experts in gas metrology. Dr Wielgosz will take up his position as Head of the BIPM Chemistry Section in May 2000.

10 OTHER BUSINESS

Brief reports of activities in the APMP, EUROMET, SADCMET and SIM regions were presented by Dr Nomura, Dr De Leer, Dr Botha and Dr May respectively.

The President drew the attention of delegates to two documents, CCQM/00-2 and 5, that were mailed to them in advance of the meeting but not discussed during the meeting. He encouraged them to forward their comments directly to the authors.

Since it will be the last time that Dr McLaren will act as Rapporteur of the CCQM, the President thanked him for all the work done as Rapporteur during the last five meetings of the CCQM. Also, the President is glad to note that Dr McLaren will remain as a member of the CCQM. The President also thanked Dr Richard Davis for the enormous amount of work he has done as executive secretary of the CCQM since its beginning. The tasks with respect to the CCQM will be taken over by the newly appointed Head of the Chemistry Section, Dr Robert Wielgosz.

The President thanked all the participants and declared the meeting closed.

11 DATE OF NEXT MEETING

The next meeting of the CCQM was tentatively scheduled for 4-6 April 2001.

J. McLaren, Rapporteur
May 2000
revised August 2000

Table 1. A framework for CCQM comparisons and studies

(classified by field)

Description	Reference number	Pilot laboratory	Start date	Status (as of 4/2000)
Health				
Clinical diagnostic markers				
Cholesterol in serum	CCQM-P6	NIST	1998	Completed 1999
Cholesterol in serum	CCQM-K6	NIST	1999	Draft B to CCQM
Glucose in serum	CCQM-P8	NIST	1999	In progress; OK for KC
Glucose in serum	CCQM-K11	NIST	2000	
Creatinine in serum	CCQM-P9	NIST	1999	In progress; OK for KC
Creatinine in serum	CCQM-K12	NIST	2000	
Major electrolyte elements (Na, K, Ca) in serum and urine				
Trace elements (Pb, Se) in serum	CCQM-P14	NIST/LGC	1999	Abandoned (see next)
Ca in Serum	CCQM-P14	IRMM/SP	2001	
Anabolic steroids in urine				
Hormones in serum				
Food				
As in fish or shellfish	CCQM-P11	NIST	2000	Samples ready to go
Pb in wine	CCQM-P12	IRMM	2000	Samples ready to go
Cd in rice	CCQM-P29	IRMM/ NIMC	2001	
Metals in synthetic food digest	CCQM-P13	LGC	2001	Preliminary tests
Antibiotics in meat				
Growth hormones in meat				
Vitamins and minerals				
Genetically modified organisms				
Pesticide residues				
pp´-DDE in isooctane	CCQM-P2	LGC	1997	Completed
pp´-DDE in corn oil	CCQM-P4	LGC	1998	Completed
pp´-DDE in fish oil	CCQM-K5	LGC	1999	Draft B to CCQM
Gamma-HCH in fish oil	CCQM-P10	LGC	1999	Repeat (see next)

Gamma-HCH in fish oil	CCQM-P10.2	LGC	2000	
pp'-DDT in fish oil	CCQM-P21	LGC	1999	Completed 2000; OK for KC
pp'-DDT in fish oil	CCQM-K21	LGC	2000	

Drinking water

Organics (EPA list)

Trace elements

Microbiological

Environment

Water

Waste water (EPA list)

Cd and Pb in natural water	CCQM-K2	IRMM	1998	Approved for equivalence

Atmospheric pollutants

CO_2, CH_4 - ambient levels	CCQM-K14	NMi	2001	
SF_6, CFCs - emission levels	CCQM-K15	NIST/NPL	2001	
Ozone - ambient levels	CCQM-P28	NIST/NPL	2001	

Point source emissions [CO, CO_2, THC, NO_x, SO_2,…,volatile organic compounds (VOCs)]

VOC in air	CCQM-K22	NIMC	2002	

Primary standard gas mixtures

CO in N_2	CCQM-K1.a	NMi	1998	to Appendix B
CO_2 in N_2	CCQM-K1.b	NMi	1998	id.
NO in N_2	CCQM-K1.c	NMi	1998	id.
SO_2 in N_2	CCQM-K1.d	NMi	1998	id.
Natural gases	CCQM-K1.e,f,g	NMi	1998	id.
Natural gas - Repeat	CCQM-K23	NMi	2003	
Natural gas (more than 4 carbon atoms)	CCQM-K16	BAM/NMi	2001	
CO, CO_2, propane in N_2	CCQM-K3	NMi	1998	to Appendix B

CO in nitrogen (100 µmol/mol)				
gravimetry	CCQM-P23	NMi	2000	
Benzene/toluene/				
xylene in N_2/air	CCQM-K7	NIST	1999	RiP - Draft A
BTX in air				
(low conc. 10-30 nmol/mol)	CCQM-K10	NIST/NPL	2000	
Dynamic mixing methods	CCQM-P24	LNE	2000	
NO/NO_2 in air	CCQM-P?	NIST	2002	

Hazardous air pollutants (HAPs)

Contaminants in soils/sediments/incinerator ash

Pb/Cd in sediments	CCQM-P15	IRMM	1999	Draft report; go to KC
Pb/Cd in sediments	CCQM-K13	IRMM	2000	Samples ready to go
Elements in synthetic				
digest solutions	CCQM-P16	NMi	1999	Abandoned
PCBs in sediments	CCQM-P17	NRC/NIST	2000	Samples ready to go
TriButylTin in sediment	CCQM-P18	LGC/NRC	2000	Preliminary work
Metals in hard rock mine wastes				

Metals in biological tissues

Toxic metals in recycled plastics PET

Advanced Materials

Semiconductors

Ultratrace metals in high-purity semiconductors GaAs

Metal alloys

Pb in Al alloys

Trace elements in			
steel/iron	CCQM-P25	NIMC/NIST	2001

Polymers and plastics

Leachates

Trace metals

Catalysts

Pt, Rh in vehicle exhaust catalysts

Commodities

Industrial SO_2 in stack emissions	see CCQM-K1.d under ***Environment***			
Moisture in fossil fuels				
Sulphur in fuels	CCQM-P26	IRMM/NIST	2000	
Metals in lubricating oils				
Natural gases	see CCQM-K1.e,f,g under ***Environment***			
Sucrose				
Cement - Ca, Si, Al, S, Ti, Na, Mg				
Ore composition				
Rare-earth elements				
Precious metals				
Source of origin/adulteration				
Alcohol content				
Ethanol in water				

Forensics

Drugs of abuse				
LSD in urine	CCQM-P27	LGC	2000	
Explosives residues				
Ethanol in air	CCQM-K4	NPL	1999	To Appendix B
DNA profiling				

Pharmaceuticals

Biotechnology

DNA diagnostics

General analytical applications

Purity of materials metals, salts, organics, etc.

KCl, NaCl, $K_2Cr_2O_7$	CCQM-P7	NIST	1998	Work in future
Hydrochloric acid	CCQM-P19	NIST	1999	Samples ready to go
Acetanilide, benzoic acid and naphthalene	CCQM-P5	NIST	1998	Completed 1999
Purity of compounds	CCQM-P20	NIST/ NARL	1999	Continuous
NMR study	CCQM-P3	BAM	1998	Completed 1999
NMR study	CCQM-P3.2	BAM	1999	Completed 2000

Calibration solutions				
Trace elements in water Pb	CCQM-P1	NIST	1997	Completed 1998
Elemental solution standards (Al,Cu,Fe,Mg)	CCQM-K8	EMPA/ BNM-LNE	1999	RiP – Draft A
Elemental solution standards (Al,Cu,Fe,Mg)	CCQM-P30	EMPA/ BNM-LNE	1999	Completed 2000
Anions in calibration solutions	CCQM-P32	EMPA	2001	
Organic calibration solutions (PCBs, PAHs, pesticides)	CCQM-P31	NIST	2000	
pH standards				
pH 7.0 (phosphate)	CCQM-K9	PTB	1999	RiP - Draft A
pH 4.1 (phthalate)	CCQM-K17	PTB	2001	
pH 10.1 (carbonate)	CCQM-K18	SMU	2002	
pH 9.2 (borate)	CCQM-K19	?		
pH 1.7 (tetroxalate)	CCQM-K20	?		
Electrolytic conductivity	CCQM-P22	DFM	2000	EUROMET 381
Isotopic standards				

APPENDIX Q 1.
Working documents submitted to the CCQM at its 6th meeting

(see the list of documents on page 44)

LIST OF ACRONYMS USED IN THE PRESENT VOLUME

1 Acronyms for laboratories, committees and conferences

APMP	Asia/Pacific Metrology Programme
BAM	Bundesanstalt für Materialforschung und -prüfung, Berlin (Germany)
BIPM	Bureau International des Poids et Mesures
BNM	Bureau National de Métrologie, Paris (France)
BNM-LNE	Bureau National de Métrologie: Laboratoire National d'Essais, Paris (France)
CCQM	Consultative Committee for Amount of Substance
CEM	Centro Español de Metrologia, Madrid (Spain)
CENAM	Centro Nacional de Metrologia, Mexico (Mexico)
CGPM	Conférence Générale des Poids et Mesures
CIPM	Comité International des Poids et Mesures
CITAC	Cooperation on International Traceability in Analytical Chemistry
CSIR-NML	Council for Scientific and Industrial Research, National Metrology Laboratory, Pretoria (South Africa)
CSIRO-NML	Commonwealth Scientific and Industrial Research Organization, National Measurement Laboratory, Lindfield (Australia)
DFM	Danish Institute of Fundamental Metrology, Lyngby (Denmark)
EMPA	Swiss Federal Laboratories for Materials Testing and Research, Dübendorf, St Gall and Thun (Switzerland)
EUROMET	European Collaboration in Measurement Standards
GUM	Glówny Urzad Miar/ Central Office of Measures, Warsaw (Poland)
IAEA	International Atomic Energy Agency
IFCC	International Federation of Clinical Chemistry and Laboratory Medicine
IMEP	International Measurement Evaluation Programme
IMGC-CNR	Istituto di Metrologia G. Colonnetti, Consiglio Nazionale delle Ricerche, Turin (Italy)

IRMM	Institute for Reference Materials and Measurements, European Commission
ISO	International Organization for Standardization
ISO/REMCO	International Organization for Standardization: Committee on Reference Materials
IUPAC	International Union of Pure and Applied Chemistry
JCRB	Joint Committee of the Regional Metrology Organizations and the BIPM
KRISS	Korea Research Institute of Standards and Science, Taejon (Rep. of Korea)
LGC	Laboratory of the Government Chemist, Teddington (United Kingdom)
LNE	Laboratoire National d'Essais, Paris (France), see BNM
NARL	National Analytical Reference Laboratory, Canberra and Pymble (Australia)
NIM	National Institute of Metrology, Beijing (China)
NIMC	National Institute of Material and Chemical Research, Tsukuba (Japan)
NIST	National Institute of Standards and Technology, Gaithersburg (United States)
NMI	National Metrology Institute
NMi-VSL	Nederlands Meetinstituut: Van Swinden Laboratorium, Delft (The Netherlands)
NPL	National Physical Laboratory of India, New Delhi (India)
NPLI	National Physical Laboratory, Teddington (United Kingdom)
NRC	National Research Council of Canada, Ottawa (Canada)
NRCCRM	National Research Centre for Certified Reference Materials, Beijing (China)
NRLM	National Research Laboratory of Metrology, Tsukuba (Japan)
OFMET	Office Fédéral de Métrologie, Wabern (Switzerland)
OMH	Országos Mérésügyi Hivatal/National Office of Measures, Budapest (Hungary)
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig and Berlin (Germany)
RMO	Regional Metrology Organization
SADCMET	SADC Cooperation in Measurement Traceability

SIM	Sistema Interamericano de Metrologia
SMU	Slovenský Metrologický Ústav, Bratislava (Slovakia)
SP	Sveriges Provnings- och Forskningsinstitut/Swedish National Testing and Research Institute, Borås (Sweden)
VAMAS	Versailles Project on Advanced Materials and Standards
VNIIM	D.I. Mendeleyev Institute for Metrology of Gosstandart of Russia, St Petersburg (Russian Fed.)
VSL	Van Swinden Laboratorium, Delft (The Netherlands), see NMi

2 Acronyms for scientific terms

ARXPS	Angle Resolved X-ray Photoelectron Spectroscopy
CFC	Chlorofluorocarbon
CRM	Certified Reference Materials
DNA	Deoxyribonucleic Acid
GUM	Guide to the expression of uncertainty in measurement
HAP	Hazardous Air Pollutant
HPLC	High Performance Liquid Chromatography
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectrometry
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
ICP-OES	Inductively Coupled Plasma Optical Emission Spectrometry
IDMS	Isotope Dilution Mass Spectrometry
INAA	Instrumental Neutron Activation Analysis
KC	Key Comparison
KCRV	Key Comparison Reference Value
MS	Mass Spectrometry
NAA	Neutron Activation Analysis
NMR	Nuclear Magnetic Resonance
PCB	Polychlorinated Biphenyl
PET	Polyethylene Tetraphtalate
RBS	Rutherford Backscattering Spectrometry
SI	International System of Units
SRM	Standard Reference Material
TBT	Tributyltin
TEM	Transmission Electron Microscopy
THC	Total Hydrocarbon

VOC	Volatile Organic Compound
XPS	X-ray Photoelectron Spectroscopy