

Bureau International des Poids et Mesures

**Consultative Committee
for Acoustics, Ultrasound
and Vibration (CCAUV)**

1st Meeting (July 1999)

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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MEMBER STATES OF THE METRE CONVENTION

as of 20 July 1999

Argentina	Japan
Australia	Korea (Dem. People's Rep. of)
Austria	Korea (Rep. of)
Belgium	Mexico
Brazil	Netherlands
Bulgaria	New Zealand
Cameroon	Norway
Canada	Pakistan
Chile	Poland
China	Portugal
Czech Republic	Romania
Denmark	Russian Federation
Dominican Republic	Singapore
Egypt	Slovakia
Finland	South Africa
France	Spain
Germany	Sweden
Hungary	Switzerland
India	Thailand
Indonesia	Turkey
Iran (Islamic Rep. of)	United Kingdom
Ireland	United States
Israel	Uruguay
Italy	Venezuela

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 m²) 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 president 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 ACOUSTICS,
ULTRASOUND AND VIBRATION**

as of 20 July 1999

President

Dr A.J. Wallard, member of the Comité International des Poids et Mesures,
National Physical Laboratory, Teddington.

Executive secretary

Dr P. Allisy-Roberts, Bureau International des Poids et Mesures [BIPM],
Sèvres.

Members

Bureau National de Métrologie: Institut National de Métrologie [BNM-INM],
Paris.

Centro Nacional de Metrología [CENAM], Querétaro.

CSIR, National Measurement Laboratory [CSIR-NML], Pretoria.

CSIRO, National Measurement Laboratory [CSIRO], Lindfield.

Danish Institute of Fundamental Metrology [DFM], Lyngby.

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

Istituto di Metrologia G. Colonnetti [IMGC], Turin.

Istituto Elettrotecnico Nazionale Galileo Ferraris [IEN], Turin.

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

National Institute of Metrology [NIM], Beijing.

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

National Physical Laboratory [NPL], Teddington.

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

National Research Council of Canada [NRC], Ottawa.

National Research Laboratory of Metrology [NRLM], Tsukuba.

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

Office Fédéral de Métrologie [OFMET], Wabern.

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig.

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

Observers

All-Russian Research Institute for Physical, Technical and Radiophysical
Measurements [VNIIFTRI], Moscow.

Bundesamt für Eich- und Vermessungswesen [BEV], Wien.

Český Metrologický Institut/Czech Metrological Institute [CMI], Prague.

Główny Urząd Miar/Central Office of Measures [GUM], Warsaw.

Instituto Português da Qualidade [IPQ], Caparica.

International Electrotechnical Commission [IEC].

International Organization for Standardization [ISO].

National Centre of Metrology [NCM], Sofia.

Singapore Productivity and Standards Board [PSB], Singapore.

Slovenský Metrologický Ústav [SMU], Bratislava.

Ulusal Metroloji Enstitüsü/National Metrology Institute [UME], Gebze-
Kocaeli.

**Consultative Committee
for Acoustics, Ultrasound and Vibration**

Report of the 1st Meeting

(20–21 July 1999)

to the Comité International des Poids et Mesures

Agenda

- 1 Opening of the meeting; approval of the agenda; appointment of a rapporteur.
- 2 Report on the meeting of the *ad hoc* group, 10-11 March 1998.
- 3 Criteria and recommendations for membership of the CCAUV:
 - 3.1 Criteria for membership;
 - 3.2 Working groups.
- 4 Progress with key comparisons
 - 4.1 CCAUV.A-K1: airborne acoustics;
 - 4.2 CCAUV.U-K1: ultrasonic power;
 - 4.3 CCAUV.U-K2: free-field open-circuit sensitivity;
 - 4.4 CCAUV.V-K1: vibration and shock (piezoelectric accelerometers);
 - 4.5 CCAUV.W-K1: underwater acoustics;
 - 4.6 Possible future work.
- 5 Analysis of key comparison results.
- 6 Other comparisons and results to be considered for the BIPM key comparison database.
- 7 *Metrologia* special issue.
- 8 Contributions from participants:
 - 8.1 Development and improvement of national standards;
 - 8.2 Dissemination of calibration factors;
 - 8.3 Research areas.
- 9 Regional metrology organizations.
- 10 Reports from international observers:
 - 10.1 International Organization for Standardization;
 - 10.2 International Electrotechnical Commission.
- 11 Publications.

12 Other business:

12.1 Report to the General Conference;

12.2 Underwater acoustics (EUROMET);

12.3 Lack of national metrology institutes in SADC MET.

13 Date of next meeting.

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

The Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV) held its first meeting at the Bureau International des Poids et Mesures (BIPM), at Sèvres, on Tuesday 20 and Wednesday 21 July 1999.

The following were present: S. Dubnicka (SMU), J.S. Echeverría-Villagómez (CENAM), H.J. Eun (KRISS), C. Guglielmone (IEN), D. Jarvis (NPL, EUROMET), L. Jol (NMI-VSL), M. Lecollinet (BNM-INM), A. Lee Van Buren (NIST), S. Nagai (NRLM), V. Nedzelnitsky (NIST), R. Preston (NPL, IEC), T.J. Quinn (Director of the BIPM), K. Rasmussen (DFM), R. Reibold (PTB), E. Siegfried (OFMET), M. Szelag (GUM), S. Thwaites (CSIRO), I. Veldman (CSIR-NML), H.-J. von Martens (PTB, ISO), A.J. Wallard (President of the CCAUV, NPL), G. Wong (NRC).

Also attending the meeting: P. Giacomo (Director Emeritus of the BIPM), P. Allisy-Roberts (Executive Secretary, BIPM).

Apologies were received from: V. Mohanan (NPLI), A.Y. Smirnov (VNIIM), C. Teague (NIST).

The Director of the BIPM, Dr Quinn, welcomed all the members to this first meeting of the CCAUV.

The President of the CCAUV, Dr Wallard, formally opened the meeting and reiterated his welcome. He expressed the sense of history that could be felt at the BIPM and especially in the Grande Salle. He went on to express the responsibility that the CCAUV shares with the CIPM and the other Consultative Committees (CCs) towards science, metrology and international trade. Participants were then invited to introduce themselves.

Dr Wallard welcomed as observers the representatives from the international bodies, the IEC and the ISO. The fact that the CCAUV needs good links with these bodies was confirmed.

Mr I. Veldman (CSIR-NML) was nominated as rapporteur of the meeting. It was remarked that only the main discussion points need be noted.

It was proposed by the President that Item 3, criteria and recommendations for membership of the CCAUV, be deferred for discussion on the second day.

Dr Quinn requested an opportunity to convey the current position of the CIPM with regard to key comparisons.

The agenda was accepted with the two changes proposed.

2 REPORT ON THE MEETING OF THE *AD HOC* GROUP, 10 AND 11 MARCH 1998

No comments were raised regarding the *ad hoc* meeting on acoustics, ultrasound and vibration. The meeting had been held at the NPL, Teddington, on 10 and 11 March 1998.

At that meeting the initial key comparisons had been discussed and accepted. The meeting had also proposed formally to the CIPM that a Consultative Committee for Acoustics, Ultrasound and Vibration should be established as a new Consultative Committee (CC).

3 CRITERIA AND RECOMMENDATIONS FOR MEMBERSHIP OF THE CCAUV

3.1 Criteria for membership

Document CCAUV/99-2 outlines the criteria for national metrology institute (NMI) membership of CCs of the CIPM.

The following particular points were emphasized by Dr Quinn regarding CC membership:

- Only the NMIs of countries that are members of the Metre Convention may be members of a CC.
- The NMIs have CC membership or observer status and nominate representatives. This means that individuals are not members.
- However, individuals with special expertise may be invited by the President of a CC to participate as members or as observers.

The membership of CCs comprises national metrology institutes at the forefront of their field. The laboratories involved must be active in research and publish their work. These laboratories must also participate in comparisons at an international level. The NMI representatives must be experts in their field, with the willingness, commitment and dedication to participate actively in CC affairs.

Observer status may be granted to NMIs that do not fulfil the criteria for full membership. Observers may participate in CC discussions and form part of working groups as required by the CC. Observer status should not be taken as a second-class membership and the status may be changed as the criteria are fulfilled.

To become members of the CCAUV, the Director of an NMI must send a letter to the CIPM, nominating the individual that the NMI wishes to have as its representative. This letter should include the required documentation, substantiating the nominee's competence, as well as the NMI's activities in the field. This request should reach the BIPM by the end of September 1999 for consideration at the CIPM meeting in October. The NMI should also state its research activities and level of commitment towards the CCAUV.

Once the CIPM has determined the membership, the nominee of each NMI is then their representative until at least the next meeting of the CCAUV. All correspondence will be channelled through the representatives.

3.2 Working groups

It was suggested that a working group (WG) be formed to assist the CC on matters concerning the key comparisons. The members suggested for the group being the CSIRO, NIST, NPL, NRC and the PTB. The WG would have the responsibility for preparing and analysing the results of the key comparisons preparatory to entry in the central database. This would enable the CCAUV to consider the acceptance of the key comparisons within the CCAUV meeting.

Concerns regarding the requirements for working groups and the mix of expertise was discussed. The CCAUV should guard against becoming a rubber stamp for the WGs. Any specific expert from an NMI who might be required, for example a statistician, could be made a member of a WG without having to be a representative on the CCAUV.

A working group for new research areas was also suggested. However, for the time being, no decision was made on either of these proposed WGs. It was

agreed that the pilot laboratories should keep Dr Wallard informed on a six-monthly basis via e-mail or fax on the progress of the key comparisons.

4 PROGRESS WITH KEY COMPARISONS

After some debate the following nomenclature was adopted:

CCAUV.X-Y, where:

- CC denotes “Consultative Committee”
- AUV denotes “Acoustics, Ultrasound and Vibration”
- X denotes the metrology field:
 - A = Acoustics
 - U = Ultrasound
 - V = Vibration
 - W = Underwater acoustics
- Y denotes the comparison type:
 - K = Key comparison
 - S = Supplementary comparison
 - P = Pilot study
- followed by a sequential number.

For regional key comparisons, CC is replaced by the regional metrology organization’s acronym, separated by a dot. For example the first CC key comparison for acoustics, sound pressure in air, is: CCAUV.A-K1. The number for the corresponding comparison in the SADC MET region would be: SADC MET.AUV.A-K1.

This nomenclature follows the rules adopted by the other CCs.

In the future, when the CC comparison is repeated, the number for the key comparison, sound pressure in air, will remain as CCAUV.A-K1, but the end date (year) will be added for the preceding comparison.

Concerns were expressed regarding the time required to perform comparisons as well as the time required to enable laboratories to disseminate comparisons into the regions.

4.1 CCAUV.A-K1: airborne acoustics

The NPL is the pilot laboratory for this comparison on airborne acoustics which has twelve participants. The comparison microphones are to be calibrated at the nominal preferred frequencies in the range 63 Hz to 8 kHz. Owing to possible interference at the power line frequency, it was decided that the reporting of results at 63 Hz should be optional.

There was some confusion regarding the coverage factor for the reporting of uncertainties, whether to use $k = 1$ or $k = 2$. Laboratories should report the uncertainty of measurement for $k = 1$. For the certificate, the laboratory should report the results following their own requirements for issuing certificates and the coverage factor should be clearly stated.

Dr Jarvis pointed out that the comparison was on a very tight schedule. Each laboratory has only six weeks allocated to calibrate the microphones. The microphones may be returned to the NPL earlier than the due date but not later than the allocated six weeks. The results have to reach the pilot laboratory within two weeks of the completion of the calibration. If a time lag caused by the postal service is envisaged as a problem, then the pilot laboratory should be informed and the results sent to the pilot laboratory via e-mail. The pilot laboratory should inform a laboratory immediately of any possible problem(s).

Dr Jarvis indicated that the preliminary results could be ready by the summer of 2001.

The CSIRO suggested that it might be able to extend its measurement capabilities to 8 kHz in time for the comparison.

A low-frequency key comparison (20 Hz to 63 Hz) for sound pressure in air was proposed.

4.2 CCAUV.U-K1: ultrasonic power

The PTB is the pilot laboratory for this comparison on ultrasonic power in which there are nine participants. On Dr Beissner's behalf, Dr Reibold presented the measurement techniques and results performed by the PTB on the ultrasound transducer chosen for the comparison (CCAUV/99-24 and 25). The PTB had studied the transducer extensively and it was requested that these results be made available to other laboratories.

It was questioned whether or not a rectifier module developed by the NIST should be used for the comparison. The NIST indicated that they will make the rectifier available to all the participants of the comparison. As using a

rectifier is effectively a new method, participants would be encouraged to employ both methods in order to compare the results and to identify any discrepancies, although it was to be understood that the rectifier method would be optional.

The comparison should be completed by the end of 2001.

4.3 CCAUV.U-K2: free-field open-circuit sensitivity

Two hydrophones will be used for this comparison on free-field open-circuit sensitivity. The scope of the comparison, which includes seven participants (see CCAUV/99-3 for details) with the NPL as pilot laboratory, involves measurements at 1 MHz, 2 MHz, 5 MHz, 10 MHz and 15 MHz. The NPL will finalize the timetable once the participants have indicated their preferred time slots.

Confirmation from the NMIs is needed that the following laboratories are maintaining the national standards for their countries: the DFM-FORCE (Dr Rasmussen to confirm) and the HAARI (Dr Quinn will write to the NIM for confirmation), so that they may participate in the comparison.

4.4 CCAUV.V-K1: vibration and shock (piezoelectric accelerometers)

There are twelve participants for this comparison of piezoelectric accelerometers with the PTB as the pilot laboratory. All the issues that were raised during the meeting at the NPL in 1998 are now resolved. At present, laser interferometry is accepted as the only primary method traceable to units of the International System of Units (SI) for vibration measurements.

The revised protocol was presented by Dr von Martens (CCAUV/99-4). A charge amplifier will not be circulated with the transfer standard accelerometers, as these units (Type 26) do not have adequate long-term stability. The CSIRO, NIST and PTB reported that improved comparison results have been obtained without circulating a charge amplifier with the standards. It was agreed that each laboratory should therefore use its own charge amplifier which should be calibrated prior to performing the comparison measurements.

The timetable is now complete. It was noted that the accelerometer standards must be hand-carried whenever being sent from or returned to the PTB.

4.5 CCAUV.W-K1: underwater acoustics

The pilot laboratory is the NPL and up to six NMIs are expected to participate. Three hydrophones will be needed to cover the frequency range from 1 kHz to 500 kHz.

Dr Preston commented that this is the least developed field in the CCAUV with relatively few NMIs able to participate. Confirmation was needed as to whether HAARI holds the national standard for China. The CSIRO reported that there is a demand for underwater acoustics in Australia, but as yet they do not have a standard. There are no designated underwater acoustics standards in France.

4.6 Possible future work

The possibilities for future key comparisons were discussed, the comment being made that not all measurements had to be the subject of a key comparison.

4.6.1 Sound level calibrators

Sound level calibrators will not be considered for key comparisons in acoustics. These devices are understood to be secondary instruments.

4.6.2 Half-inch microphones (LSP2)

The meeting was in agreement that this will be a required key comparison. The use of LSP2 devices extends the current frequency range of CCAUV.A-K1. The concern at this stage is the fact that only a few laboratories can perform primary calibrations of these devices.

4.6.3 Free-field calibration of half-inch microphones

The NIST expressed a requirement for a key comparison in this area. There was consensus that this is a growing requirement although at present not enough laboratories have such capabilities. It was agreed that there is a need to develop and improve measurement techniques for the calibration of microphones in free-field conditions.

4.6.4 Phase response of half-inch microphones

A comparison of the phase response of half-inch microphones was considered as a supplementary comparison. It was agreed that this would also be appropriate for hydrophone phase comparisons.

4.6.5 Phase, shock and angular velocity

The PTB indicated possible requirements for key comparisons of phase, shock and angular velocity for vibration measurements.

5 ANALYSIS OF KEY COMPARISON RESULTS

The President led the discussion on the analysis of comparison results. He raised the determination of the key comparison reference value (KCRV) and consideration of the uncertainty budgets as points for discussion. He cautioned the participants that this matter should be considered in advance of obtaining and analysing comparison results. Mean values and weighted mean values were mentioned as possibilities for each KCRV. Weighting factors should be based on scientific discussions.

The consideration of the analysis of results proved difficult without specific examples. It was agreed, however, that the analysis process should be as transparent as possible for the proper discussion of results, with measurement uncertainties a major consideration. The results may need to be analysed differently for each key comparison. As this will be a lengthy undertaking, pilot laboratories should start the process by drafting a report as soon as the comparison draws to a close.

It was suggested that informal WGs be formed to analyse the results of each key comparison enabling the exchange of experiences and ideas while keeping the results confidential. It was agreed that a given KCRV assigned to a comparison could be a nominal value (for example a calibration factor) rather than an absolute SI value and would be treated as nominal for the comparison and the presentation of the results.

6 OTHER COMPARISONS AND RESULTS TO BE CONSIDERED FOR THE BIPM KEY COMPARISON DATABASE

Two types of comparison results are to be considered for the BIPM key comparison database. These are comparisons between NMIs at international level (CIPM comparisons) and comparisons at regional level (regional metrology organizations).

Only NMIs that are party to the Metre Convention may have their data entered into the database. NMIs participating through a regional comparison may only present comparison results for the BIPM key comparison database through their regional bodies. Comparison results can only be presented to the BIPM for entry into the database with the permission of all the laboratories which participated in the comparison. All key comparison results are presented for approval to the CC. A laboratory might elect not to have its results entered into the database. (Secretarial note: this is no longer acceptable following the revised Mutual Recognition Arrangement (MRA) of October 1999. If an NMI participates in a key comparison, their finally agreed result will be entered in the database.)

Examples of current and past regional comparison results were presented from the APMP, EUROMET, NORAMET and SIM regions. The pilot laboratories must ensure that the comparisons are numbered according to the CC numbering convention. Some of these comparisons have already been published in *Metrologia*, in some cases with the laboratories remaining anonymous.

It was suggested that the technical analysis of comparison results should be made by the leading laboratories in the regional metrology organizations. It was noted that the CSIRO has to obtain permission from all the laboratories that participated in the APMP regional comparison for vibration measurements before the results can be entered into the database.

7 METROLOGIA SPECIAL ISSUE

Papers in all fields had now been submitted for publication in the special issue of *Metrologia* on acoustics, ultrasound and vibration (1999, volume 36, number 4). The papers were being refereed and although the journal edition would not be published in time, a full contents page would be available for the CGPM meeting in October 1999.

8 CONTRIBUTIONS FROM PARTICIPANTS

Short reports had been submitted by most of the CCAUV members regarding development, dissemination and research in their respective laboratories. Each of the members present gave a brief overview of the current status of work in their laboratories.

8.1 Development and improvement of national standards

PTB: CCAUV/99-8. Most of the activities in the acoustics department were running as EUROMET projects. Five development areas were presented.

CCAUV/99-9. Uni-axial calibration of motion transducers, achievements and limitations.

NRC: CCAUV/99-10. Systems which have been developed included microphone calibration, high-power ultrasound standard and accelerometer calibration.

CSIRO: CCAUV/99-15. Underwater acoustics measurements in Australia.

OFMET: CCAUV/99-17. Reciprocity calibration of laboratory standard microphones. The laboratory performs free-field measurements but not free-field reciprocity calibration.

KRISS: CCAUV/99-19. KRISS maintains national standards in acoustics and vibration.

GUM: CCAUV/99-21. The laboratory maintains primary standards for acoustics but not for vibration.

CENAM: CCAUV/99-22. Primary vibration calibration using laser interferometry or reciprocity is performed over the range 50 Hz to 5 kHz. Primary microphone calibration using reciprocity is carried out over the range 63 Hz to 8 kHz. High-power ultrasonic measurement capabilities are being developed.

CSIR-NML: A system for reciprocity calibration of LSP1 microphones was completed by 1990. The system is currently being upgraded and automated. A laser interferometer system was established in 1997 covering the range from 50 Hz to 500 Hz using the ratio counting method. This system is also being upgraded to cover the full range from 1 Hz to 10 kHz.

NIST: The NIST is in the process of developing a new reciprocity system for pressure calibration of laboratory standard microphones. The vibration facility is also being upgraded. A system for vibration calibration using reciprocity and laser interferometry simultaneously is also being developed.

8.2 Dissemination of calibration factors

OFMET: CCAUV/99-17. Standards are disseminated through pattern evaluation, verification of sound level meters, calibrators and filters.

KRISS: CCAUV/99-19. Dissemination of the national measurement standards in acoustics and vibration is performed under the umbrella scheme of the National Calibration System (NCS).

GUM: CCAUV/99-21. Acoustics standards are disseminated according to the relevant IEC standard. Vibration standards are disseminated according to the relevant ISO standard with traceability to the PTB.

8.3 Research areas

PTB: CCAUV/99-8. Five research areas in the acoustics department were presented.

CCAUV/99-9. Novel equipment for simultaneous multi-component calibration of motion transducers.

NRC: CCAUV/99-10. Research is mainly taking place on microphone calibrations.

KRISS: CCAUV/99-19. Research in the acoustics and vibration laboratory is divided into measurement standards and applications.

CENAM: CCAUV/99-22. Research is focussed on reducing measurement uncertainties for their existing systems.

NIST: Research is on free-field reciprocity calibration of microphones. The NIST is also researching gating techniques and techniques using semi-anechoic chambers.

DFM: Current research is on microphone measurements at low frequency to determine the correct heat conduction theory.

9 REGIONAL METROLOGY ORGANIZATIONS

APMP: In a few months' time, the CSIRO is handing over the APMP secretariat to Japan. Apart from the comparison activities as outlined in document CCAUV/99-14, training activities are taking place between national laboratories with contracts in place for Thailand this year.

EUROMET: The Acoustics Group as well as the Vibration Group have met in 1999. The Underwater Acoustics Group has still to meet (see CCAUV/99-11: EUROMET annual acoustics report). Information on EUROMET activities can be accessed at www.euromet.org.

SIM: Comparison results were presented with reasonable agreement using three transducers for comparison by laser interferometry methods. In the acoustics field, four laboratories participated with 0.004 dB agreement between the results.

It was noted that all regional metrology organizations should check the calibration and measurement capabilities (CMCs) for entry into Appendix C of the MRA and should submit this to the Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB) by the end of 1999 for review at their meeting in the spring of 2000. The data supplied for Appendix C of the MRA must be compatible with the laboratory's uncertainty of measurement as should the uncertainties stated on certificates and for comparisons.

It was agreed that comparisons cannot be made to support every measurement. The aim of the MRA is to give confidence in each NMI's measurement capabilities.

10 REPORTS FROM INTERNATIONAL OBSERVERS

The President presented a letter from the chairman of ISO/TC 108 stating ISO's support to the CCAUV.

10.1 International Organization for Standardization

The International Organization for Standardization (ISO) representative, Dr von Martens, reported on ISO/TC 108/SC 3 (Use and calibration of vibration and shock measuring instruments), the ISO 5347 series of documents and its revision, as well as the progress made in the revision of standards and the preparation of new ones. He also gave a brief summary of the liaison between the ISO and the BIPM. For details see document CCAUV/99-12.

10.2 International Electrotechnical Commission

IEC TC 87 – Ultrasonics: the International Electrotechnical Commission (IEC) representative, Dr Preston, reported on the scope of TC 87 and provided information on the standards used relating to the various areas of ultrasonics (CCAUV/99-13).

IEC TC 29 – Electroacoustics: Dr Preston also reported on the scope of TC 29 with a brief description of the work performed by the TC. He provided information on the standards and the work programme of TC 29 (CCAUV/99-13).

11 PUBLICATIONS

Each NMI agreed to send to the BIPM a list of all their publications in areas related to the CCAUV. Ideally the list should be sent electronically using the *Metrologia* format. It was agreed that the list should consist only of publications for the last two years with the aim of posting it on the BIPM website as a CCAUV activity.

12 OTHER BUSINESS

12.1 Report to the General Conference

The President will present a formal report to the General Conference on the outcome of the CCAUV meeting. He requested that all material that could be useful for his report, for example illustrations or relevant data, be sent to him by the end of August 1999.

12.2 Underwater acoustics (EUROMET)

Dr Preston was encouraged to contact all institutes with underwater acoustics capabilities that are not NMIs, or do not have direct links with NMIs, to establish such links that would enable them to register their measurement capabilities through regional comparisons, such as the EUROMET underwater acoustics comparison which in turn would be linked to the CCAUV comparisons.

For CC and regional comparisons the NMI must submit a formal recognition that the particular institute maintains the national standard for underwater acoustics for the comparison results to be acceptable.

12.3 Lack of national metrology institutes in SADC MET

The CSIR-NML, currently the only national metrology institute in SADC MET, expressed its wish to participate in comparisons within other regions. This was agreed to be desirable.

13 DATE OF NEXT MEETING

It was recommended that the next meeting be held in mid September 2001. The CIPM will decide the actual date. Working groups for the various key comparisons will be activated as required.

Mr I. Veldman, Rapporteur
June 2000,
revised October 2000

APPENDIX A 1.**Working documents submitted to the CCAUV at its 1st meeting**

(see the list of documents on page 35)

LIST OF ACRONYMS USED IN THE PRESENT VOLUME

1 Acronyms for laboratories, committees and conferences

APMP	Asia/Pacific Metrology Programme
BEV	Bundesamt für Eich- und Vermessungswesen, Wien (Austria)
BIPM	Bureau International des Poids et Mesures
BNM	Bureau National de Métrologie, Paris (France)
BNM-INM	Bureau National de Métrologie: Institut National de Métrologie, Paris (France)
CC	Consultative Committee of the CIPM
CCAUV	Consultative Committee for Acoustics, Ultrasound and Vibration
CENAM	Centro Nacional de Metrologia, Mexico (Mexico)
CIPM	Comité International des Poids et Mesures
CMI	Český Metrologický Institut/Czech Metrological Institute, Prague (Czech Rep.)
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)
ETL	Electrotechnical Laboratory, Tsukuba (Japan)
EUROMET	European Collaboration in Measurement Standards
FORCE	Force Institute, Brøndby (Denmark)
GUM	Główny Urząd Miar/Central Office of Measures, Warsaw (Poland)
HAARI	Hangzhou Applied Acoustic Research Institute, Zhejiang (China)
IEC	International Electrotechnical Commission
IEN	Istituto Elettrotecnico Nazionale Galileo Ferraris, Turin (Italy)
IMGC	Istituto di Metrologia G. Colonnetti, Turin (Italy)

INM*	Institut National de Métrologie, Paris (France), see BNM-INM
IPQ	Instituto Português da Qualidade, Caparica (Portugal)
ISO	International Organization for Standardization
JCRB	Joint Committee of the Regional Metrology Organizations and the BIPM
KRISS	Korea Research Institute of Standards and Science, Taejon (Rep. of Korea)
MRA	Mutual Recognition Arrangement
NCM	National Centre of Metrology, Sofia (Bulgaria)
NIM	National Institute of Metrology, Beijing (China)
NIST	National Institute of Standards and Technology, Gaithersburg (United States)
NMI	National metrology institute
NMi-VSL	Nederlands Meetinstituut: Van Swinden Laboratorium, Delft (The Netherlands)
NORAMET	North American Metrology Cooperation
NPL	National Physical Laboratory, Teddington (United Kingdom)
NPLI	National Physical Laboratory of India, New Delhi (India)
NRC	National Research Council of Canada, Ottawa (Canada)
NRC-INMS	National Research Council of Canada, Institute for National Measurement Standards, Ottawa (Canada)
NRLM	National Research Laboratory of Metrology, Tsukuba (Japan)
OFMET	Office Fédéral de Métrologie/Eidgenössisches Amt für Messwesen, Wabern (Switzerland)
PSB	Singapore Productivity and Standards Board, Singapore (Singapore)
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig and Berlin (Germany)
SADCMET	SADC Cooperation in Measurement Traceability
SIM	Sistema Interamericano de Metrologia
SMU	Slovenský Metrologický Ústav/Slovak Institute of Metrology, Bratislava (Slovakia)
UME	Ulusal Metroloji Enstitüsü/National Metrology Institute, Gebze-Kocaeli (Turkey)

VNIIFTRI	All-Russian Research Institute for Physical, Technical and Radiophysical Measurements, Moscow (Russian Fed.)
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

CMC	Calibration and measurement capabilities
KCRV	Key comparison reference value
SI	International System of Units