Bureau International des Poids et Mesures

Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV)

2nd Meeting (October 2001)

Note on the use of the English text

To make its work more widely accessible the International Committee for Weights and Measures 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 International Bureau of Weights and Measures (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 International Committee for Weights and Measures (CIPM) which itself comes under the authority of the General Conference on Weights and Measures (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), time scales (1988) and to chemistry (2000). 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, in 1984 for the laser work and in 1988 for a library and offices. In 2001 a new building for the workshop, offices and meeting rooms 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, the *Director's Report on the Activity and Management of the International Bureau of Weights and Measures*, 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:

- *Report of the meeting of the General Conference on Weights and Measures;*
- *Report of the meeting of the International Committee for Weights and Measures;*
- *Reports of Meetings of Consultative Committees.*

The BIPM also publishes monographs on special metrological subjects and, under the title *The International System of Units (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 *Director's Report on the Activity and Management of the International Bureau of Weights and Measures.*

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 5 October 2001

President

Dr J. Valdés, member of the International Committee for Weights and Measures, Instituto Nacional de Tecnología Industrial, San Martin.

Executive Secretary

Dr P.J. Allisy-Roberts, International Bureau of Weights and Measures [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.

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

Danish Institute of Fundamental Metrology [DFM]/Danish Primary Laboratory for Acoustics [DPLA], Naerum.

Istituto Elettrotecnico Nazionale Galileo Ferraris [IEN], Turin.

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

National Institute of Metrology [NIM], Beijing.

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

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

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

National Physical Laboratory [NPL], Teddington.

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

National Research Council of Canada [NRC], Ottawa.

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

Office Fédéral de Métrologie et d'Accréditation [METAS], Wabern.

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig.

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

Observers

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

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

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

Glówny Urzad Miar/Central Office of Measures [GUM], Warsaw.

Instituto Português da Qualidade [IPQ] /Laboratório Nacional de Engenharia Civil [LNEC], Lisboa.

International Electrotechnical Commission [IEC].

International Organization for Standardization [ISO].

National Centre of Metrology [NCM], Sofia.

Slovenský Metrologický Ústav/Slovak Institute of Metrology [SMU], Bratislava.

Standards, Productivity and Innovation Board [SPRING], Singapore.

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

Consultative Committee
for Acoustics, Ultrasound and Vibration

Report of the 2nd Meeting

(4–5 October 2001)

to the International Committee for Weights and Measures

Agenda

1 Opening of the meeting; approval of the agenda; appointment of a rapporteur.
2 Report on the first meeting of the CCAUV.
3 Progress with key comparisons.
4 Key comparison results.
5 Other key comparisons and results to be considered for the BIPM key comparison database.
6 Future comparisons.
7 Publications.
8 Contributions from participants.
9 Regional Metrology Organizations.
10 Reports from international observers.
11 Other business.
12 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 second meeting at the International Bureau of Weights and Measures (BIPM), Sèvres, on Thursday 4 and Friday 5 October 2001.

The following were present: R. Barham (NPL), S. Barrera-Figueroa (CENAM), G. Basile (IMGC-CNR, expert for the IEN), F. Berthod (METAS), J.S. Echeverría-Villagómez (CENAM), E. Frederiksen (DFM/DPLA), C. Guglielmone (IEN), A. Konkov (VNIIFTRI, representing the VNIIM), M. Lecollinet (BNM-INM), V. Mohanan (NPLI), T.J. Quinn (Director of the BIPM), K. Rasmussen (DFM/DPLA), R. Reibold (PTB), S. Robinson (NPL), S. Sato (NMIJ/AIST), E. Siegfried (METAS), S.J. Suh (KRISS), S. Thwaites (NML CSIRO), T. Usuda (NMIJ/AIST), J. Valdés (President of the CCAUV), A.L. Van Buren (representing the NIST), P. van Kan (NMi VSL), I. Veldman (CSIR-NML), H.-J. von Martens (PTB, ISO), A.J. Wallard (CIPM, NPL), G. Wong (NRC), B. Zeqiri (NPL).

Observers: M. Bartos (CMI), S. Dubnicka (SMU), A. Enyakov (VNIIFTRI), A.E. Isaev (VNIIFTRI), E. Sadikoglu (UME), M. Sinojmeri (BEV), M. Szelag (CMI).

Invited: G. Ripper (INMETRO).

Also attending the meeting: P. Giacomo (Director emeritus of the BIPM), P.J. Allisy-Roberts (Executive Secretary, BIPM), C. Thomas (BIPM).

Apologies were received from: V. Nedzelnitsky (NIST), G. Rietveld (NMi VSL), V.Y. Smirnov (VNIIM).

The Director of the BIPM, Dr Quinn, extended a welcome to all the members to the second meeting of the CCAUV being held in the new Pavillon du Mail of the BIPM, and summarized the administrative arrangements.

The President of the CCAUV, Dr Valdés, formally opened the meeting and welcomed all the participants. A brief introduction was made by each of the participants, observers and guests. Apologies were noted from members unable to attend.

Mr Veldman (CSIR-NML) was appointed Rapporteur.

The agenda was adopted without change.

2 REPORT ON THE FIRST MEETING OF THE CCAUV

Prof. Wallard (previously interim President of the CCAUV) gave a brief report on the minutes of the first meeting of the CCAUV and corrected a mistake on page 71: the second paragraph of section 10.2 on IEC TC 29 Electroacoustics should read: "Dr Rasmussen reported on the scope of TC 29… (CCAUV/99-16)."

He then briefly reviewed the history of the CCAUV including the events leading to its establishment and a summary of the key comparisons identified during its first meeting. He commented that the handling of key comparison results and the determination of key comparison reference values (KCRVs) would be important items for future consideration.

Dr Valdés agreed that the method of calculation of the KCRV must be considered separately for each key comparison.

3 PROGRESS WITH KEY COMPARISONS

3.1 CCAUV.A-K1

Mr Barham reported that the measurement phase of key comparison CCAUV.A-K1 on sound pressure in air had run smoothly and was completed in April 2001 (CCAUV/01-10). He remarked that the travelling microphones had remained stable, with the NPL obtaining a typical standard deviation of less than 0.01 dB during the measurement phase.

The draft A confidential report of the comparison was distributed amongst the participants present at the meeting. Mr Barham suggested that a separate meeting of the participants of the key comparison should be organized to discuss the calculation of the KCRV, the presentation of the data and other details required for the final key comparison report. He commented that satisfactory agreement was obtained between the different methods used to determine the KCRV.

The President enquired whether the microphones were available if required by a laboratory for any further measurements. Mr Barham confirmed that the

microphones were purchased explicitly for the purpose of the key comparison and are indeed available for further measurements.

Dr Wong noted that the stability of measurements obtained was better than had been anticipated. He also commented that the uncertainty for each national metrology institute (NMI) result should be considered when examining the degrees of equivalence.

Dr Quinn explained that the KCRV is only part of the key comparison. The KCRV should not be seen as an everlasting value. It is only valid for the respective key comparison. He further commented that the key comparison results are useful data that can be used to validate calibration and measurement capabilities (CMCs) of an NMI.

3.2 CCAUV.A-K2

It was noted that key comparison CCAUV.A-K2 on low-frequency sound pressure in air has not yet started; the protocol is currently under consideration.

3.3 CCAUV.U-K1

Dr Reibold reported that progress continues with the key comparison CCAUV.U-K1 on ultrasonic power (CCAUV/01-02). Seven of the nine participating laboratories have completed the measurements. The PTB (the pilot laboratory) will produce the draft A report once all the results are received. An investigation has begun of the various methods that may be used to determine the KCRV.

The KRISS indicated that they would like to participate in the repetition of this key comparison that is planned for 2007-2008.

3.4 CCAUV.U-K2

Dr Zeqiri mentioned that the Russian and Australian laboratories had withdrawn from the list of participants for key comparison CCAUV.U-K2 on ultrasonic pressure using a membrane hydrophone as a transfer device, but that the NIM representing China had been added.

The protocol describing the calibrations to be made, which was circulated to participants in 2001, also contains information regarding the care of the devices, treatment of uncertainties, and guidance on the reporting of the results.

All the participants have now completed the calibrations and submitted their reports. It is expected that the draft A report, written by the NPL, will be circulated to the participants by the end of October 2001.

Dr Zeqiri commented that the results from laboratories not using a primary method, but rather a secondary method traceable to another laboratory, should not be included in the KCRV. This means that results from only four laboratories will be used for the KCRV.

As a general point it was noted that all laboratories participating in any key comparison must submit a full uncertainty budget to the pilot laboratory. An expanded uncertainty value alone is not sufficient.

Dr Allisy-Roberts remarked that the degree of equivalence was determined from both the difference between the reported measurement value and the KCRV and the associated expanded uncertainty of this difference. Dr Quinn added that in cases where all the offsets lie within the uncertainty limits, the participants of that key comparison may wish to add a comment to the key comparison result to the effect that "The key comparison showed that there are no significant differences between any of the results."

3.5 CCAUV.V-K1

Dr von Martens reported (CCAUV/01-04) that all twelve laboratories participating in key comparison CCAUV.V-K1 on vibration acceleration have completed the calibration measurements. The comparison began in January 2000 and was completed as planned in June 2001. It is expected that the draft A report will be finished by the end of 2001.

The comparison involved one single-ended and one back-to-back accelerometer. The laboratories were required to measure the sensitivity of the accelerometers without applying a mirror or a dummy mass to the accelerometer. It was evident from the results that some of the laboratories experienced some difficulty in measuring the single-ended accelerometer.

It was commented that although two primary calibration techniques, laser interferometry and reciprocity, exist for the calibration of accelerometers, no laboratory used the latter method during the comparison as this was not included in the protocol.

Dr von Martens presented the results of some investigations performed at the PTB concerning the KCRV for both accelerometers. Five different techniques for determining the KCRV were considered: the mean, a weighted mean, the median, the maximum likelihood and a polynomial fit. Dr von

Martens presented data indicating that the different methods deviated by only 0.1 % from the weighted mean value when applied to the back-to-back accelerometer results, while nearly all of the results of the twelve participants were within 0.5 % of the weighted mean KCRV that was presented. On the basis of the PTB's findings, he recommended that the weighted mean be adopted as the KCRV for both the back-to-back accelerometer and the single-ended accelerometer results.

Dr Quinn remarked that it is important for all participants to be comfortable with the uncertainty values reported by the different laboratories and to agree on the KCRV adopted. He added that a cut-off, best practice uncertainty value could also be used, again by means of a consensus between the laboratories.

Dr Mohanan inquired into the effect of the mounting torque on the measurement results. Dr von Martens replied that a mounting torque of 2 N m was specified in the key comparison protocol and that investigations by the PTB show that deviations from this specified value of up to 40 % have little if any influence on the measured sensitivity.

The effect of differences between the mountings of the accelerometers by the various laboratories was also discussed. It was generally agreed that a difference in torque settings will not influence the results reported by the various laboratories, but a difference in mounting fixtures might well result in deviations in results reported.

Dr Basile suggested that to minimize the spread of the results obtained during comparisons, an accelerometer with a conditioning amplifier could be circulated as the calibration artefact. Dr von Martens responded that this issue had been debated in the ISO community. Until two years ago, it was believed that the calibration of an accelerometer with a conditioning amplifier was the best practice. After some adverse experiences when employing this method, it was demonstrated that the conditioning amplifier was unstable relative to the accelerometer. A study made at the PTB, using a commercial accelerometer (Brüel & Kjær 8305s) over a twenty-four month period, showed that these devices are stable to about 0.05 % over an eighteen-month period. A EUROMET project on the calibration of conditioning amplifiers indicated that laboratories can accurately calibrate such devices. The conclusion was that it is best to use an accelerometer on its own.

3.6 CCAUV.W-K1

Mr Robinson reported that the key comparison CCAUV.W-K1 on underwater acoustics was progressing satisfactorily (CCAUV/01-12). There are six confirmed participants in this comparison: Canada, China, Germany, Russia, United States and the United Kingdom. Japan has also indicated interest, but has not confirmed its participation.

Three hydrophones are to be measured in the comparison, covering the frequency range 1 kHz to 500 kHz. To date, four laboratories have completed the measurements. The remaining measurements should be completed early in 2002.

The CSIR-NML indicated its interest in participating in the comparison. Mr Robinson will contact Mr P. Botha of the CSIR-NML to confirm their participation.

4 KEY COMPARISON RESULTS

4.1 Key comparison reference values

Dr Quinn reminded the Committee that the Mutual Recognition Arrangement (MRA) does not define how the KCRV should be determined. The participants must reach a consensus on the method to be used. In general, three basic methods are used to determine the KCRV: the mean, median or weighted mean. If a consensus is reached on the reported uncertainty values, then the weighted mean method is often preferred. If some reported uncertainty values are very much smaller than expected, then the weighted mean can still be used but with some cut-off values (best practice) for the NMI uncertainties. The mean of the results is sometimes favoured when a large number of results is available. In general, if the different methods give comparable values for the KCRV then the comparison results can be considered satisfactory.

Dr Allisy-Roberts opened the discussion on how to identify outlier results and possible actions to take. She said that all the data should be considered and that if a result is obviously an outlier, then the guidelines set by the BIPM on key comparisons should be followed and the laboratory concerned contacted and informed. It should not be necessary to perform statistical

analysis to identify outliers. If subsequent to investigation a result remains outside the expected value for the comparison, it may be included in the evaluation of the KCRV if an appropriate method is used (such as the median or weighted median) if the participants agree. Even if not included in the evaluation of the KCRV, all results are valid for the key comparison and will be included in the BIPM key comparison database (KCDB). The President commented that key comparisons could help NMIs to identify possible systematic errors in their calibration systems.

Mr Barham agreed that outliers could be identified by visual inspection of the results. However, he was concerned that a participating laboratory might feel that their result was an outlier and would prefer the opportunity to make a recalculation. A solution might be to circulate the results anonymously, providing the laboratories with the opportunity to decide for themselves if they felt results were outliers or not.

Dr Wong suggested that the results should be examined with a certain value in mind, for instance in the case of CCAUV.A-K1 a value of 0.05 dB can be used, as recommended by the IEC specification on reciprocity calibration of laboratory standard microphones. Mr Barham commented that key comparison values should be “state of the art”. Dr Rasmussen commented that the aim of the key comparison was to realize the pascal and not just to follow the IEC suggestion for the estimation of uncertainty. The IEC value in IEC 61094-2 should therefore only be used as a guide that was indeed appropriate at the time the standard was written but is no longer “state of the art”.

The President commented that the manipulation of the data for determining the KCRV should be related to the device used during the key comparison. Dr Quinn commented that values to be used to identify outliers could be decided upon by the participants at the start of a key comparison.

Dr Allisy-Roberts and Prof. Wallard emphasized again that for key comparisons all participants must submit a complete uncertainty budget together with their results.

4.2 Analysis of results

Dr Quinn pointed out that it should be possible to use the KCRV obtained during a CIPM key comparison as the KCRV to be used in a regional comparison. However, this would only be possible if the same method used during the CIPM comparison was also used during the regional comparison,

with at least two laboratories participating in both comparisons. Examples are available from the BIPM on request.

Dr von Martens enquired whether the same device might be used for both a CIPM comparison and a regional comparison. Dr Quinn confirmed that this would be allowed. It was noted that if the reference values for the devices used were made public they could not be used subsequently in a regional comparison.

Dr Allisy-Roberts noted that during a similar CCRI key comparison using transfer standards, the reference value was not made public, but was reported as a ratio. The same comparison could therefore be run as a regional comparison.

4.3 Format and content of draft B reports

Dr Allisy-Roberts suggested that the participants and especially the pilot laboratories could use the presentation of the photometry key comparison results (CCPR-K3.b) on the BIPM website as a model for their reports. It was noted that draft B reports should include all the data as well as graphical representations of equivalence as appropriate for Appendix B of the MRA.

4.4 Data for the BIPM key comparison database

There are many good examples of key comparison results that have been published in the KCDB. The results presented for the pressure comparison CCM.P-K1.c could be used as a model for the presentation of CCAUV comparison results.

4.5 Time scales

It was noted that key comparisons typically proceed along the following time scales:

- six months for the list of participants and the comparison protocol to be established;
- two years for the measurements to be completed;
- three months for the draft A report to be compiled by the pilot laboratory, once all the results have been received;
- one month for the participants to send comments and for agreement to be reached;

- three months for the draft B report to be completed.

Thus in general it takes at least three years to complete a key comparison.

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

Dr Allisy-Roberts confirmed that she would coordinate the publication of results of regional key comparisons on the BIPM website. She asked the pilot laboratories of such comparisons to submit their proposals, protocols and final reports to the CCAUV for approval.

5.1 APMP.AUV.V-K1

Dr Sang Joon Suh reported that the PTB and seven laboratories from the Asia Pacific Metrology Programme (APMP) participated in the APMP key comparison APMP.AUV.V-K1 of vibration measurements over the frequency range 10 Hz to 10 kHz (CCAUV/01-08). The comparison had been piloted by the CMS/ITRI. The comparison results were published in early 2001 as an APMP Report that is available on the KCDB website.

Dr Allisy-Roberts commented that the APMP comparison should be linked to the CIPM comparison and asked if this would be possible. Dr von Martens supported the motion for accepting the APMP comparison into the KCDB. He commented that the PTB had been invited to participate in the comparison and he considered it well organized. He said that the CIPM requirements will be met for linking the APMP comparison to the CIPM comparison and that he will accept responsibility for performing the task of linking the two comparisons.

Prof. Wallard inquired if the results of participants who took part in both the CIPM comparison and the APMP comparison stayed in the same relationship to each other in both comparisons; this was confirmed by Dr von Martens. Prof. Wallard remarked that only results of participants in the MRA are entered into the KCDB. Dr Allisy-Roberts added that comparison results of non-participants could nevertheless be included in the final report of the comparisons that is published.

5.2 EUROMET.AUV.A-K1

Mr Barham reported that seventeen laboratories participated in the EUROMET comparison on acoustics, EUROMET.AUV.A-K1. The comparison was organized by three pilot laboratories each of which held a comparison with a sub-group of participants. The three pilot laboratories then also participated in comparisons with each other, enabling them to link all the results. The measurements were completed in 1999. The deviations of the results for the LS1P microphones ranged from 0.07 dB to 0.19 dB at 10 kHz and those for the LS2P microphones from 0.04 dB to 0.12 dB at 20 kHz.

The results of the comparison have not yet been published, as the results of CCAUV.A-K1 are needed in order to establish the link for the KCDB. There are three laboratories linking the EUROMET and CCAUV comparisons. The data will be circulated for approval by the CCAUV in 2002.

5.3 EUROMET.AUV.U-K1 and EUROMET.AUV.U-K2

Dr Zeqiri reported that the EUROMET ultrasound comparison EUROMET.AUV.U-K1 is still in the planning stage and that the arrangements for EUROMET.AUV.U-K2 will be finalized at the forthcoming EUROMET meeting.

5.4 EUROMET.AUV.V-K1

Dr von Martens indicated that EUROMET project 579 (2003-2005) would be used as the EUROMET key comparison for vibration, identified as EUROMET.AUV.V-K1 (CCAUV/01-03). He noted that devices similar to those used in the CCAUV comparison would be used for this comparison and said that the proposed frequency range for the EUROMET comparison of 10 Hz to 10 kHz would be modified to 40 Hz to 5 kHz to correspond to CCAUV.V-K1.

Dr Allisy-Roberts and Dr Reibold asked whether Dr von Martens expected to see different results from the two comparisons (CIPM and EUROMET). Dr von Martens replied that he was confident that the devices would perform similarly as they are of very high quality.

5.5 SIM.AUV.A-K1

Dr Wong gave a detailed report on the SIM comparison for acoustics SIM.AUV.A-K1 (CCAUV/01-07). This comparison was started in August

1997 and completed by March 2000. The pilot laboratory used a statistical mean to calculate the KCRV. Two microphones were used during the comparison and the results indicated that one of these microphones was more stable than the other.

Dr Rasmussen noted that the pilot laboratory had used the sensitivity values measured for the microphones at the start and end of the comparison cycle as an indication of stability. He recommended that the variation of the sensitivity values over the comparison period should be used instead, to give a better indication of instabilities.

Dr Echeverría-Villagómez noted that there was a problem to be solved in linking the results to those of the CCAUV.AUV.A-K1. Dr Quinn asked whether the results of the common participants to both comparisons stayed in the same relationship to each other in both comparisons. Dr Echeverría-Villagómez showed this was not the case. Dr Quinn recommended that the inconsistencies be resolved within the SIM. Dr Wong and Dr Echeverría-Villagómez agreed to do this before the comparison is considered for the KCDB. It was suggested that the uncertainty budgets of the participant NMIs should be examined carefully.

5.6 SIM.AUV.A-K2 (SIM.AUV.A-K1.PREV)

Dr Rasmussen reported on the results of SIM comparison SIM.AUV.A-K2 on the calibration of LS1P microphones between the CENAM, DPLA, INMETRO and the INTI (CCAUV/01-09). Two microphones were circulated from one laboratory to the next, with DPLA acting as the pilot laboratory. Due to an abrupt change in the sensitivities of the microphones before the completion of the comparison, the results were compared in two groups, using the calibration results at the DPLA before and after the circulation as references. A subsequent comparison between the CENAM and the DPLA confirmed the results of the first comparison. The maximum root-mean-square deviation from the mean value for the two LS1P microphones measured by the DPLA, INMETRO and the INTI was 0.038 dB and that measured by the DPLA and the CENAM was 0.032 dB. The larger value, 0.038 dB, was adopted as the key comparison reference value.

Dr Allisy-Roberts indicated that the start date of the comparison needed to be changed to April 1997 in the KCDB and that the reference for the comparison would be changed to SIM.AUV.A-K1.PREV as it was a comparison previous to the SIM.AUV.A-K1.

5.7 SIM.AUV.V-K1

It was reported that the SIM vibration comparison SIM.AUV.V-K1 had been completed successfully. The pilot laboratory has analysed the final results and is waiting for one of the participants to confirm their result. The data will be submitted to the CCAUV at a later date.

6 FUTURE COMPARISONS

6.1 CCAUV

The CCAUV agreed that the first round of key comparisons should be repeated in 2007-2008.

The key comparison CCAUV.A-K2 on sound pressure in air over the frequency range 20 Hz to 63 Hz is planned to start in 2002. No participating laboratory will be required to make measurements at power line frequencies (50 Hz or 63 Hz).

A need to perform comparisons at very low frequencies, down to 1 Hz, was identified.

Dr von Martens raised the question of how well the key comparisons support the submitted CMCs in the area of acceleration. It was commented that 80 % to 85 % of CMCs submitted in the area of acceleration were covered as only a few laboratories had submitted CMCs for accelerometer phase measurements.

Mr Robinson intimated that more comparisons were required in the area of underwater acoustics. He proposed a low-frequency comparison.

Dr Thwaites raised a concern regarding industry's requirement for traceability in airborne acoustics below 125 Hz, noting that the industry generally uses LS2 microphones whereas the key comparison CCAUV.A-K1 was based on LS1 microphones. She suggested that a wideband comparison of the pressure calibration of LS2P microphones be organized.

It was noted that a large number of laboratories in Europe are able to perform reciprocity calibrations of LS2P microphones, but currently not many laboratories outside Europe have this capability. Dr Rasmussen reported that a free-field comparison had successfully been completed by EUROMET. He

noted that more than 30 % of the calibrations performed in industry are traceable to LS2 microphones. Dr Guglielmone commented that Italy uses LS2 microphones for the dissemination of the standard for airborne acoustics and supported the request for a key comparison using LS2 microphones.

The following laboratories indicated that they would like to participate in a free-field key comparison using LS2P microphones: the BEV, BNM-LNE, CENAM, DPLA, NIST, NMIJ, NPL and the PTB.

Finally, two key comparisons in the area of airborne acoustics were proposed: one for pressure response in the frequency range 31.5 Hz to 20 kHz; and the other for free-field response in the frequency range 1 kHz to 25 kHz. An LS2P microphone would be used as the transfer standard. Nineteen laboratories showed interest in participation. It was agreed that the workload and responsibility of running the two comparisons would be shared: the DPLA would supply and measure the microphones; the CENAM would manage the comparisons and write the proposal; the CSIRO, DPLA and the NPL would assist with formulating the protocol and form a working group to assist in drafting the comparison results. It was proposed that the comparisons would start in January 2003.

6.2 Regional

Dr Wong reported that the SIM is undertaking a comparison using a piston phone that should be completed by the end of January 2002. It was noted that comparisons of piston phones are regarded as supplementary and thus there will be no need to calculate a KCRV or degrees of equivalence. Dr Quinn commented that supplementary comparisons are performed for specific needs within a region and are usually relevant to specific CMC entries.

It was noted that it is a regional responsibility to run supplementary comparisons. However, as such comparisons should be conducted using the same guidelines as for key comparisons, they should be registered with the Executive Secretary. The protocol for the SIM comparison in question, identified as SIM.AUV.A.S1 in the KCDB, had indeed been submitted to Dr Allisy-Roberts.

A planned APMP microphone key comparison will be discussed at the APMP AUV working group meeting in Japan during November 2001.

A COOMET key comparison in airborne acoustics, COOMET.AUV.A-K1, is under way with participating laboratories from Germany, Poland, Russia, Slovakia, Turkey and Ukraine. This comparison is scheduled for completion by the end of 2002.

Dr Quinn commented that bilateral comparisons need to be handled in the same manner as CIPM key comparisons if their results are to be considered for inclusion in the KCDB.

7 PUBLICATIONS

7.1 *Metrologia* special issue

Dr von Martens reported that many experts in various fields of metrology including Dr B. Douglas, Chairman of ISO TC 108, had expressed pleasure concerning the *Metrologia* special issue **36**(4), 1999, on acoustics, ultrasound and vibration.

Dr Quinn recommended that the CCAUV encourage experts to write monographs on specific topics that the BIPM can then publish as reference works for the AUV community.

7.2 Key comparison reports

Dr Quinn made the point that some reports and short papers could be published in *Metrologia*; pilot laboratories may publish technical observations made as a result of key comparisons. He mentioned that the BIPM is planning to establish a Technical Supplement to *Metrologia* purely for the publication of comparison results. This supplement will be web-based only. This is to ensure that final reports can be published in their entirety whereas publication space in *Metrologia* is limited. An editorial describing the new supplement would be published shortly in *Metrologia* **39**(1).

7.3 CCAUV web pages

7.3.1 NMI contributions

Dr Allisy-Roberts reminded members that one of the requirements for CC membership was the need to be active in research. She invited members to submit updated lists of publications. As these lists are published as submitted, she requested that complete lists be sent each time, rather than just a list of updates.

7.3.2 Search engine and useful links

Dr Quinn informed the meeting of a new search engine (www.search.bipm.org) available on the BIPM website. This enables powerful searches of the websites of all NMIs in States that are Member States of the Metre Convention or Associates of the General Conference on Weights and Measures (CGPM). Dr Quinn demonstrated the new search engine, using key words as well as authors for search options.

It was noted that the BIPM website provides links to all the NMI sites (see www.bipm.org/links) and if appropriate, a link to AUV publications on an NMI's site could be made from the CCAUV web page. Members were invited to contact the Executive Secretary with such details.

8 CONTRIBUTIONS FROM PARTICIPANTS

All the participants gave a brief overview of the status and work in their laboratories. Details are available as indicated in the working documents submitted to the CCAUV. In addition some of the participants made oral presentations.

8.1 Development and improvement of national standards

BEV

Reporting on progress at the BEV, Dr Sinojmeri (CCAUV/01-17) mentioned that plans are in hand to put a state-of-the-art Brüel and Kjaer reciprocity calibration system (Type 9699) into operation by the end of 2001. Several computer programs are being developed in the acoustics section for model approval, verifying and calibrating different types of sound level meters in accordance with IEC 60651, IEC 60804, IEC 61672 and sound calibrators in accordance with IEC 60942. Measurement methods and test procedures are also being developed for measuring equipment (loudspeakers and tapping machines) for building acoustics and noise emission.

BNM-INM

Mr Lecollinet reported (CCAUV/01-01) that although the BNM has no capabilities in ultrasound or underwater acoustics, it has capabilities in air-borne acoustics through the BNM-INM which maintains reciprocity calibration of acoustic microphones and the BNM-LNE where a system for pressure calibration by reciprocity is maintained. The BNM-LNE has also developed a system for free-field calibration by reciprocity and maintains anechoic as well as semi-anechoic facilities. This laboratory is responsible for type testing and periodic verification of sound measuring equipment for legal purposes. Acceleration is maintained by the CEA-CESTA (an associate laboratory of the BNM) that is in charge of the primary system for the calibration of accelerometers.

CENAM

Dr Echeverría-Villagómez presented a report (CCAUV/01-15) for the CENAM; the laboratory is concentrating on lowering the uncertainties for their accelerometer calibrations and a force balance is being developed for ultrasound measurements.

CSIR-NML

In his report for the CSIR-NML (CCAUV/01-18), Mr Veldman mentioned that in acoustics the laboratory is finalizing the development of its automated reciprocity calibration system for LS1P microphones to calibrate sensitivity as well as the phase response of microphones, and will also be in a position to calibrate LS2P microphones.

A laser interferometer system based on the successive approximation system has been successfully implemented over the frequency range 1 kHz to 5 kHz for vibration measurements; an extension is planned to cover the range from 10 Hz to 10 kHz. The development of a low-frequency system to cover the range from 1 Hz to 40 Hz is scheduled for early 2002. Future developments include primary shock calibration systems.

The area of ultrasound, including medical ultrasound and underwater acoustics is one of the newest areas of development. The laboratory has acquired non-destructive testing (NDT) probes, an ultrasound power source, standard needle hydrophones, underwater acoustic projectors and receivers to offer traceability to industry. A reciprocity system is in the final stages of validation for the calibration of underwater acoustic sensors.

A 10-axis controller is under construction to enable ultrasound beam plotting from the end of October 2001 and a secondary radiation force balance is to be investigated for medical ultrasound.

DPLA

In his presentation, Dr Rasmussen (CCAUV/01-13) announced that the DPLA is a member of DANIAMET, an umbrella company covering all primary and reference laboratories in Denmark. It is the responsibility of the DPLA to maintain and disseminate the basic units in the field of acoustics. Through research they develop and improve methods for primary and secondary calibrations in the field.

GUM

Mrs Szelag described developments in two areas of work (CCAUV/01-20) concerning the GUM. A primary standard of sound pressure (based on IEC 61094-2) has been developed from the system for measurement of front volume of LS1 and WS1 microphones. The most important mechanical elements (chamber, rings and bases) have been designed in cooperation with the NPL and manufactured by the GUM mechanical workshop. The new capability to determine individual values of LS1 microphone front volumes has made it possible to reduce significantly (down to 0.03 dB at low frequencies) the overall uncertainty of determinations of pressure sensitivity for LS1 microphones.

Recently efforts have been made to build a measuring system (with a laser interferometer) for absolute calibration of accelerometers in accordance with the ISO standard 16063-11 in the frequency range from 10 Hz to 10 kHz. The concept of this measuring system has been discussed with Dr von Martens from the PTB and the measuring instruments will soon be delivered from Germany.

KRISS

Dr Sang Joon Suh described (CCAUV/01-08) developments at the KRISS on:

- an environmental control chamber for the reciprocity calibration of LS1P and LS2P microphones;
- a computer-controlled data acquisition system for accelerometer calibration by laser interferometry;
- a free-field reciprocity system for LS1F and LS2F microphones;

- a low-frequency accelerometer calibration system;
- a shock calibration system.

NMIJ

Dr S. Sato reported for the NMIJ (CCAUV/01-19) that a reciprocity calibration system for free-field sensitivity has been developed and that ultrasonic standards (power and hydrophone calibration) are being created.

The ultrasonic power standard being established uses a radiation force balance over the frequency range 1 MHz to 20 MHz and the power range 1 mW to 10 W.

A laser interferometer system is under development for the calibration of ultrasonic pressure standards. The initial stage will cover the frequency range 1 MHz to 20 MHz for hydrophone calibrations.

For vibration acceleration standards, two systems in compliance with ISO 16063-11 have been established. One system is for the middle and high-frequency range (20 Hz to 5 kHz) for which the acceleration range lies within 1 m/s^2 to 100 m/s^2. The other system is for the low-frequency range (1 Hz to 200 Hz) where the acceleration range lies between 0.1 m/s^2 and 100 m/s^2. Only the voltage sensitivity of the specified system is provided, based on the Japan Calibration Service System regulations. Charge sensitivity will be calibrated on request. The relative uncertainty for voltage sensitivity calibration is in the range 0.3 % to 1.5 % ($k = 2$) and is frequency dependent.

NML CSIRO

Dr Thwaites indicated that the CSIRO has unfortunately had to terminate its ultrasound facilities.

NPLI

Dr Mohanan mentioned that the NPLI has received strong support from the Indian government to establish a reciprocity system for the calibration of LS2P microphones, as well as a laser interferometer system based on the fringe counting method.

PTB

Dr Reibold informed the meeting that at the PTB standards are being developed for airborne ultrasound over the frequency range 20 kHz to

200 kHz (CCAUV/01-02). Work is also under way to extend the frequency range of ultrasonic hydrophones to 50 MHz, with a bilateral comparison with the NPL planned in this area.

8.2 Dissemination of calibration factors

Dr Suh commented that the calibration system at the KRISS for WS2P microphones has been improved (CCAUV/01-08).

Dr Rasmussen reported (CCAUV/01-13) that in the last year the DPLA had issued about sixty primary reciprocity calibration certificates for microphones and a hundred and fifty-five certificates for the laser calibration of accelerometers. The laboratory also maintains a large number of internal microphones.

8.3 Research areas

Dr Mohanan said that the NPLI is developing an anechoic chamber for industry as well as acoustic research and consultancy facilities.

In his report (CCAUV/01-08), Dr Suh stated that the KRISS is undertaking various studies on the human response to sound in the living environment for the purpose of establishing a related database on the effects of noise and vibration on the human body; the identification of noise sources; and the development of noise reduction technologies for high-speed trains.

Dr Rasmussen mentioned (CCAUV/01-13) that the major research activities at the DPLA are related to the improvement of methods related to the calibration of microphones, extending both the frequency and dynamic range. Various projects are in hand including the low-frequency (1 Hz to 20 Hz) calibration of microphones by reciprocity in closed couplers; high-level pressure calibration (up to 174 dB); the influence of geometry at high frequency in electrostatic actuator calibrations; radial wave motion in couplers; reciprocity calibration in WS microphones in closed couplers; different methods of free-field reciprocity calibration of microphones; calibration methods for artificial mastoids and impedance transducers; low-frequency (0.5 Hz to 30 Hz) laser calibration of accelerometers and double-beam laser calibration of accelerometers.

Dr Basile reported on research being performed at the IMGC-CNR on a laser interferometer system with increased sensitivity for accelerometer calibration.

8.4 Future needs relating to AUV metrology (CIPM report)

Dr Valdés commented (CCAUV/01-16) on the CIPM document on national and international needs relating to metrology published in 1998 as a first response to Resolution 11 of the 20th CGPM in 1995. The report focused on the role of the BIPM and the need to improve international harmonization of measurements. It stated the basis for the MRA signed in 1999 by the directors of the national metrology institutes of the Metre Convention. Now the Secretary of the CIPM is preparing a second document, addressing more technical considerations on future needs for metrology. The final version of this document will be presented at the CGPM in 2003 and will summarize future metrological challenges.

The President continued by highlighting current developments in sensor technologies, particularly the development of ever smaller transducers in acoustics. The smallest conceivable objects are now being developed at the nanometre scale in almost every field of technology, including applications in acoustics. Important prospective studies show that nanotechnology is the most likely area of science and engineering to produce the breakthroughs of tomorrow.

Miniaturization is also becoming important in the field of vibration, with the development of new micro-electromechanical systems, including accelerometers and seismometers. Smart piezoelectric accelerometers with wireless interfaces for industrial applications are being developed. Car airbags provide a good example of how the cost of technology is decreasing, while functionality is increasing. The Center for Space Microelectronics Technology at the Jet Propulsion Laboratory (NASA) is developing a suite of miniature seismometers and accelerometers for planetary and micro-gravity science.

The President invited Dr T.J. Witt to present work performed at the BIPM on $1/f$ noise, as areas for possible application within the fields of acoustics, ultrasound and vibration. Dr Witt gave a talk entitled "Stochastic Correlations in dc Electrical Measurements" in which he emphasized that random correlations have a limiting effect on the standard deviation of the mean of repeated measurements. He also showed how methods used for describing correlations, such as the spectral density function, make it possible to detect the limit of noise arising from measuring systems.

Dr Sato described work being performed in Japan on a four-quadrature laser interferometer system. The system suppresses x-offset and has a high signal-to-noise ratio. He also showed a seismic calibration system being developed

and concluded with an overview of a system for testing temperature and humidity effects on accelerometers.

Prof. Wallard proposed that an informal working group be formed to collect contributions for a report on future activities in the fields of AUV. The working group will correspond via e-mail and all proposals should be sent to and be coordinated by the NPL. It is proposed that the submissions be made in the form of a plan of CCAUV activities, with possible projects for collaboration identified. The target date is the end of 2001. The President will use the report to inform the CIPM.

9 REGIONAL METROLOGY ORGANIZATIONS

Mrs Szelag provided feedback on the status of the EUROMET CMC submissions and this is included in the sections below.

Remarking that SIM CMCs were reviewed during the working group meeting in February 2001, Dr Wong expressed his concern that it still seemed they had not been submitted to the KCDB. Dr Allisy-Roberts confirmed that these CMCs had been received officially from the SIM and that the BIPM was awaiting a formal statement from the RMO. When some possible misunderstandings were raised regarding CMC submissions, Dr Thomas reminded the Committee that the official procedure for CMC submissions must be followed. The RMO representative has to make a formal declaration of CMCs to Dr Quinn. Even if CMC data have been submitted to the BIPM, they cannot be officially accepted by the Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB) without an official request to Dr Quinn from the RMO representative. It was noted that the JCRB meets twice a year and the time schedule for submissions is available on the BIPM website.

9.1 CMC entries submitted to the BIPM key comparison database

A total of fifty-five submissions from the EUROMET were reviewed for approval during a special meeting held in February 2001 at the BIPM. These had appeared in the KCDB in April 2001, at the same time as the initial submissions from APMP and SADCMET.

Dr Wong confirmed that the formal process to declare the SIM CMCs that had already been approved would be completed as quickly as possible.

9.2 Proposed new CMCs

EUROMET data from Austria, Greece, Hungary and The Netherlands are under review for the next JCRB meeting. The submissions are to be presented to the JCRB for approval in 2002.

Mr G. Ripper asked whether CMCs for the calibration of charge amplifiers could be submitted. The CCAUV confirmed that CMCs for charge amplifiers were not appropriate.

Dr Allisy-Roberts reported that during the working group meeting in February at the BIPM, the NMIs indicated that they would like to submit CMCs in the area of force sensitivity (of the order of pC/N up to 16 kHz). The need for such CMCs was presented to the CCM for consideration. The CCM accepted the proposal that the CCAUV handle any submissions in this area.

It was noted that CMCs will continue to be submitted and published, but this should be strictly through the official submission procedure.

10 REPORTS FROM INTERNATIONAL OBSERVERS

10.1 ISO

A report (CCAUV/01-05) on work being performed by the ISO was given by Dr von Martens. Since the first meeting of the CCAUV, there have been two ISO meetings. Work is currently being carried out on ISO standards 16063-11, -12, -13, -14, -15, -21, -22 and -23. The ISO will follow the IEC approach in the field of acceleration and the OIML requirements will be included in the ISO standards.

10.2 IEC

Dr van Buren drew attention to work being carried out by the Underwater Acoustics Maintenance Team under the auspices of Working Group 8 of

IEC/TC 87 Working Group 8 on the revision of IEC standards 60565 and 60565A on calibration of hydrophones. He commented that the next five to seven years would see the rationalization of these standards.

Dr Rasmussen reported (CCAUV/01-14) that the IEC and OIML reached agreement for including OIML documents as an appendix to the relevant IEC standards. These IEC documents will be published in four parts as a joint publication with the OIML. He intimated that Part 5 of the standard for microphone calibration by the comparison method has been approved and is now in press.

Dr Preston's report on work performed by IEC TC 87 (CCAUV/01-06) was presented by Mr Robinson. IEC Technical Committee 87 on ultrasonics has been active in the development of international specification standards in the field of ultrasonics, with particular emphasis on medical applications. The terms of reference of TC 87 are so defined to prepare standards related to the characteristics (including those of biological effects and of corresponding limits) and to the methods of measurement and specifications for fields, equipment and systems in the domain of ultrasonics. This scope includes the preparation, for use by product committees, of standards covering those aspects of ultrasound pertaining to human safety. It was also reported that close liaison will be maintained with TC 62 and that consideration of safety procedures was allocated to TC 87 in 1992 covering aspects of ultrasound germane to human health.

Ultrasonic technology finds a wide range of medical and industrial applications. As a result, the majority of the current work of TC 87 is oriented towards ultrasonic aspects related to human health, the performance of medical instruments and to human safety in ultrasonic fields.

New developments in power transducer design for low ultrasonic frequency application in industry, more sophisticated arrays and signal processing techniques in the medical ultrasonic imaging applications, and 3D techniques under development will shape demand for future work in TC 87 related to standards. New advances at the ultra-high frequency range (up to 75 MHz and above) will establish requirements for new standards.

Specification standards have therefore been established or are under development covering the following three broad areas of calibration and measurement technology in the field of ultrasonics:

- specification of hydrophone performance and calibration methods;
- measurement of ultrasonic power;
- ultrasonic field measurement.

Traceable calibrations of hydrophones and radiation force balances are therefore needed worldwide in order to support IEC specification standards in these areas.

Dr Rasmussen described work performed by IEC TC 29 on electroacoustics (CCAUV/01-14). The present scope of TC 29 is to prepare international standards related to instrumentation and methods of measurements in the field of electroacoustics. Specifically excluded from the terms of reference because they are covered by other committees, are the following standards:

- for sound and video recording (dealt with by TC 100);
- for equipment in the field of audio and audiovisual engineering (dealt with by TC 100);
- for ultrasonic techniques (dealt with by TC 87).

It was noted that close cooperation would, however, be maintained with TC 87 in the fields of common interest.

It had been agreed between the OIML and the IEC that TC 29 will take over the work that has, until now, been carried out by OIML/TC 13 on measuring instruments for acoustics and vibration. Thus, a number of relevant IEC standards are presently being prepared jointly by the IEC and OIML and will, if OIML procedures allow for this, be published as joint IEC-OIML publications.

The standards produced by TC 29 are used by governmental authorities as well as by industry. It is very important that experts preparing these draft standards represent research and development as well as test laboratories, industrial production, quality control and the users.

11 OTHER BUSINESS

It was noted that the BIPM could make all the CCAUV working documents available on CD on request. The Committee expressed the view that this would not be necessary.

Mr Veldman reported that the Acoustics, Ultrasound and Vibration Laboratory of the CSIR-NML was accredited during 2001.

Mr Ripper advised the meeting that INMETRO intends to apply for membership of the CCAUV.

12 DATE OF NEXT MEETING

It was proposed that an early meeting of the CCAUV be held to discuss the draft B results of key comparisons as many of these would become available within twelve months. The BIPM supported this proposal which will ease the organizational efforts of the BIPM if not all Consultative Committee meetings are held in the same year.

The next CCAUV meeting will be held on 1 and 2 October 2002.

Mr I. Veldman, Rapporteur

May 2002

APPENDIX A 1.
Working documents submitted to the CCAUV at its 2nd meeting

(see the list of documents on page 43)

LIST OF ACRONYMS USED IN THE PRESENT VOLUME

1 Acronyms for laboratories, committees and conferences

AIST*	National Institute of Advanced Industrial Science and Technology, see NMIJ/AIST
APMP	Asia/Pacific Metrology Programme
BEV	Bundesamt für Eich- und Vermessungswesen, Vienna (Austria)
BIPM	International Bureau of Weights and Measures/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)
BNM-LNE	Bureau National de Métrologie, Laboratoire National d'Essais, Paris (France)
CC	Consultative Committee of the CIPM
CCAUV	Consultative Committee for Acoustics, Ultrasound and Vibration/Comité Consultatif de l'Acoustique, des Ultrasons et des Vibrations
CCM	Consultative Committee for Mass and Related Quantities/Comité Consultatif pour la Masse et les Grandeurs Apparentées
CCPR	Consultative Committee for Photometry and Radiometry/Comité Consultatif de Photométrie et Radiométrie
CCRI	Consultative Committee for Ionizing Radiation/Comité Consultatif des Rayonnements Ionisants
CEA-CESTA	Commissariat à l'Énergie Atomique, CESTA, Le Barp (France)
CENAM	Centro Nacional de Metrología, Mexico (Mexico)
CGPM	General Conference on Weights and Measures/ Conférence Générale des Poids et Mesures
CIPM	International Committee for Weights and Measures/ Comité International des Poids et Mesures

* Organizations marked with an asterisk either no longer exist or operate under a different acronym.

CMI	Český Metrologický Institut/Czech Metrological Institute, Prague (Czech Rep.)
CMS/ITRI	Centre for Measurement Standards of the Industrial Technology Research Institute, Hsinchu (Taiwan)
COOMET	Cooperation in Metrology among the Central European Countries
CSIR-NML	Council for Scientific and Industrial Research, National Metrology Laboratory, Pretoria (South Africa)
CSIRO*	see NML CSIRO
DANIAMET	Metrological organization of Danish primary and reference laboratories
DFM	Danish Institute of Fundamental Metrology, Lyngby (Denmark)
DPLA	Danish Primary Laboratory for Acoustics, Naerum (Denmark)
ETL*	Electrotechnical Laboratory, Tsukuba (Japan), see NMIJ/AIST
EUROMET	European Collaboration in Measurement Standards
GUM	Glówny Urzad Miar/Central Office of Measures, Warsaw (Poland)
IEC	International Electrotechnical Commission
IEN	Istituto Elettrotecnico Nazionale Galileo Ferraris, Turin (Italy)
IMGC-CNR	Istituto di Metrologia G. Colonnetti, Consiglio Nazionale delle Ricerche, Turin (Italy)
INM*	Institut National de Métrologie, Paris (France), see BNM-INM
INMETRO	Instituto Nacional de Metrologia, Normalizaçao e Qualidade Industrial, Rio de Janeiro (Brazil)
INTI	Instituto Nacional de Tecnología Industrial, Buenos Aires (Argentina)
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, Daejeon (Rep. of Korea)
LNE*	Laboratoire National d'Essais, Paris (France), see BNM-LNE

LNEC	Laboratório Nacional de Engenharia Civil, Lisbonne (Portugal)
METAS	(formerly the OFMET) Office Fédéral de Métrologie et d'Accréditation, Wabern (Switzerland)
MRA	Mutual Recognition Arrangement
NASA	National Aeronautics and Space Administration, Washington DC (United States)
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)
NMIJ/AIST	National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology, Tsukuba (Japan)
NML CSIRO	National Measurement Laboratory, CSIRO, Lindfield (Australia)
NPL	National Physical Laboratory, Teddington (United Kingdom)
NPLI	National Physical Laboratory of India, New Delhi (India)
NRC	National Research Council of Canada, Ottawa (Canada)
NRLM*	National Research Laboratory of Metrology, Tsukuba (Japan), see NMIJ/AIST
OFMET*	Office Fédéral de Métrologie/Eidgenössisches Amt für Messwesen, Wabern (Switzerland), see METAS
OIML	Organisation Internationale de Métrologie Légale
PSB*	Singapore Productivity and Standards Board, Singapore (Singapore), see SPRING
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig and Berlin (Germany)
RMO	Regional Metrology Organization
SADCMET	SADC Cooperation in Measurement Traceability
SIM	Sistema Interamericano de Metrología
SMU	Slovenský Metrologický Ústav/Slovak Institute of Metrology, Bratislava (Slovakia)

SPRING	(formerly the PSB) Standards, Productivity and Innovation Board, Singapore (Singapore)
UME	Ulusal Metroloji Enstitüsü/National Metrology Institute, Gebze-Kocaeli (Turkey)
VNIIFTRI	All-Russian Research Institute for Physical, Technical and Radiophysical Measurements, Gosstandart of Russia, Moscow (Russian Fed.)
VNIIM	D.I. Mendeleyev Institute for Metrology, Gosstandart of Russia, St Petersburg (Russian Fed.)
VSL*	Van Swinden Laboratorium, Delft (The Netherlands), see NMi

2 Acronyms for scientific terms

AUV	Acoustics, Ultrasound and Vibration
CMC	Calibration and Measurement Capabilities
KCDB	BIPM Key Comparison Database
KCRV	Key Comparison Reference Value
NDT	Non-destructive Testing