Bureau International des Poids et Mesures

Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV)

Report of the 3rd meeting
(1 – 2 October 2002)
to the International Committee for Weights and Measures

Comité international des poids et mesures

Bureau international des poids et mesures	Organisation intergouvernementale de la Convention du Mètre

Note:

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

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

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

LIST OF MEMBERS OF THE CONSULTATIVE COMMITTEE FOR ACOUSTICS, ULTRASOUND AND VIBRATION

as of 1 October 2002

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/Istituto di Metrologia Gustavo Colonnetti del Consiglio Nazionale delle Ricerche [IMGC-CNR], 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.

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig.

Swiss Federal Office of Metrology and Accreditation [METAS], Bern-Wabern.

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

Observers

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

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

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

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

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

International Electrotechnical Commission [IEC].

International Organization for Standardization [ISO].

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

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

State Agency for Metrology and Technical Surveillance [SAMTS], Sofia.

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

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

The Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV) held its third meeting at the Bureau International des Poids et Mesures (BIPM) Sèvres, on Monday 1 and Tuesday 2 October 2002.

The following were present: R. Barham (NPL), C. Barreau (BNM-INM), S. Barrera-Figueroa (CENAM), G. Basile (IMGC-CNR), K. Beiβner (PTB), J.-N. Durocher (BNM-INM), J.S. Echeverría-Villagómez (CENAM), A. Elías-Juarez (CENAM), J. Filliben (NIST), E. Frederiksen (DPLA), C. Guglielmone (IEN), M. Lecollinet (BNM-INM), V. Nedzelnitsky (NIST), T.J. Quinn (Director of the BIPM), K. Rasmussen (DPLA), R. Reibold (PTB), S. Robinson (NPL), S. Sato (NMIJ/AIST), V. Smirnov (VNIIM), S.J. Suh (KRISS), S. Thwaites* (NML CSIRO), T. Usuda (NMIJ/AIST), J. Valdés (President of the CCAUV), A.L. Van Buren (NIST), P. van Kan (NMi VSL), C.S. Veldman (CSIR-NML), H.-J. von Martens (PTB, ISO TC108), G. Wong (NRC), Yue Zhang (NIM), B. Zeqiri (NPL).

Observers: A. Enyakov (VNIIFTRI), A. Konkov (VNIIFTRI), E. Sadikoglu (UME), M. Sinojmeri (BEV), M. Szelag (GUM).

Invited: G. Ripper (INMETRO).

Also attending the meeting: P. Giacomo (Director emeritus of the BIPM), P.J. Allisy-Roberts (Executive Secretary, BIPM), C. Thomas (Coordinator of the BIPM key comparison database), A.J. Wallard (Deputy Director, Director Designate of the BIPM).

Apologies were received from: M. Bartos (CMI), F. Berthod (METAS), A.E. Isaev (VNIIFTRI), S.M. Lee (SPRING Singapore), V. Mohanan (NPLI), R. Preston (IEC TC87), (NIST), A. Todorova (NCM).

The Director of the BIPM, Dr Quinn, welcomed the members to this third meeting of the CCAUV held at the BIPM. He apologized for not being able to attend the entire meeting explaining that Prof. Andrew Wallard, his Deputy, would be present.

Prof. Wallard reflected briefly on the history of the CCAUV, commenting that its objective was not only to execute key comparisons.

The President, Dr Valdés, formally opened the meeting and welcomed all the participants. Apologies were noted from members unable to attend, followed by a brief introduction by each of the participants, observers and guests. Dr Valdés summarized the agenda, giving a brief overview of the objectives of the meeting.

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* Dr Suzanne Thwaites died tragically on 7 October 2003 and this report is dedicated to her memory.

Mr Veldman, CSIR-NML, was apointed as *Rapporteur* for a third term. He was invited to compile the report immediately after the CCAUV meeting in an effort to expedite the report.

The agenda (CCAUV/02-00) was accepted as presented, with no proposals for change.

2 REPORT ON THE SECOND MEETING OF THE CCAUV, OCTOBER 2001

The President delivered a short summary of the full report of the 2nd meeting of the CCAUV, highlighting important issues and complimenting the participants in the various key comparisons.

3 PROGRESS AND RESULTS OF KEY COMPARISONS

The BIPM, through a working group, had proposed guidelines (CCAUV/02-36) for the evaluation of key comparison data and producing the key comparison reference value (KCRV). Dr Quinn confirmed that the document would be published in *Metrologia*. He emphasized that the document should be seen as guidance.

A lengthy debate followed. Dr Filliben of the NIST expressed his strong views against the use of the weighted mean as a method of determining the KCRV. He was concerned that this method would be widely implemented as the weighted mean is the method favoured by the guidance document.

Dr Quinn disagreed with Dr Filliben's suggestion that if the BIPM published the guide document, it would be seen as the only way to calculate reference values. He expressed the view that the publication would encourage experts to publish their research either in support or opposition of the guidance.

Dr Filliben’s views were met with opposition from some of the delegates. At the second convocation of the CCAUV, the pilot laboratories had presented investigations into the application of different methods for determining the KCRV for the different key comparisons. The methods that were considered included the mean, median, weighted mean and others. Data was presented that showed negligible differences between the methods for the key comparisons in question. In cases where the weighted mean had been applied, the pilot laboratory performed “validation checks” on the results to determine the robustness of the calculations. In cases where such checks revealed unsatisfactory results, different methods were then used to determine the KCRV for that specific measurement.

3.1 CCAUV.A-K1

Mr Barham presented the Draft B report (CCAUV/02-27) on the CCAUV.A-K1 key comparison for approval by the committee. As part of his summary he commented that the aim of the comparison was to determine the sound pressure sensitivity of LSP1 microphones in accordance with IEC 61094-2. The protocol was not prescriptive as to the methodology to be followed, with the result that a variety of systems and equipment were used by the participants, making the small spread in the results even more remarkable.

The KCRV was depicted in the report as the 0 dB line on the graphs. This value was the mean value of the results obtained for the two microphones used. Degrees of equivalence for 250 Hz and 1 kHz will be reported in the BIPM key comparison database (KCDB).

As a matter of interest, Mr Barham showed results from a similar comparison that had been performed during the 1980s. A comparison between the results of the two comparisons showed an improvement in the spread of measurements from 0.2 dB in 1980 to 0.05 dB for the recent key comparison.

Dr Nedzelnitsky pointed out that the NIST used hydrogen as a filling gas and that the report mentions that some laboratories used helium as a filling gas. He was of the opinion that all the data, including the actual measurement results should be included in the report. The meeting concluded that the measurements should not be included as this would preclude the use of the same devices in future comparisons.

Dr Valdés enquired about the feasibility of using a dummy impedance to validate the response of reciprocity calibration systems. He referred to Dr Duncan Jarvis' thesis on the subject. However, the committee felt this not to be an appropriate subject for a key comparison. The main disadvantage being that such a device only validates the electrical transfer impedance of the system, leaving the acoustical transfer impedance unchecked.

The Draft B report was approved in principle and is to be circulated to all participants by e-mail for final comments. Participants will then have ten days to respond before publication proceeds.

3.2 CCAUV.A-K2

Dr Nedzelnitsky reported on the progress of the CCAUV.A-K2 comparison. He stated that the NIST is no longer able to pilot this comparison. He then raised some items for consideration for the comparison, as given in his report (CCAUV/02-39).

After some discussion, it was agreed that the lower frequency limit of 20 Hz originally proposed should be reduced, optionally, to 2 Hz. Dr Nedzelnitsky raised the issue of a suitable device to be used. Prof. Rasmussen assured the meeting that the LSP1 microphones would be suitable devices. He also pointed out that the same parameter is to be measured as in CCAUV.A-K1 and that this would eliminate the possible confusion highlighted in Dr Nedzelnitsky's report.

The BEV agreed to pilot the comparison with assistance from the NPL. The exact level and detail of assistance will be agreed upon between the two laboratories. It was suggested that the comparison

could start in the middle of 2003. The participants are likely to be the BEV, DPLA, NIST, PTB and the NPL.

3.3 CCAUV.A-K3

Dr Echeverría-Villagómez and Prof. Rasmussen, the CENAM and the DPLA being joint pilot laboratories, reported on the progress of the CCAUV.A-K3 comparison (CCAUV/02-19). Dr Echeverría-Villagómez informed the meeting that the two laboratories had agreed that the DPLA would arrange, manage and execute the key comparison while the CENAM will analyze the measurement data and compile the reports. This was accepted by the CCAUV.

Prof. Rasmussen reported that some laboratories might not be ready to participate in the CCAUV.A-K4 (LSF2 microphone) key comparison as currently scheduled in parallel with the CCAUV.A-K3 (LSP2 microphone) key comparison. The proposed frequency range of 31 Hz to 25 kHz with 31.5 kHz as an optional frequency point was accepted.

It was agreed that the comparisons CCAUV.A-K3 and CCAUV.A-K4 will be separated completely. Prof. Rasmussen will amend the protocol for the two comparisons with specific reference to the timetables and participants. Both the NIM and the INMETRO will be added to the list of participants for CCAUV.A-K3.

3.4 CCAUV.A-K4

Prof. Rasmussen presented the draft protocol for the CCAUV.A-K4 comparison (CCAUV/02-20) of the free field calibration of LS2 microphones. As mentioned at 3.3, the meeting agreed to run comparisons CCAUV.A-K3 and CCAUV.A-K4 independently of each other. The meeting took note of the unfortunate additional cost implications for laboratories participating in both comparisons.

Prof. Wallard reminded the meeting that the MRA transition period expires at the end of 2003 and that normally all key comparisons that are needed to support calibration and measurement capabilities (CMC) submissions should be completed by then.

As laboratories would probably measure both the pressure and free-field response, a proposal from Mr Barham to use the comparison to determine pressure to free-field corrections was accepted.

This comparison will be postponed to late 2003 or early 2004. The frequency range 2 kHz to 31.5 kHz with 40 kHz as optional was proposed and accepted. The protocol will be amended and redistributed to all participants.

3.5 CCAUV.U-K1

Dr Beißner reported progress with the CCAUV.U-K1 comparison (CCAUV/02-12). The main application for these measurements is in the medical field. The comparison had been executed in four loops and the device was re-measured four times by the pilot laboratory. The participants were required to report two types of voltage measurements, G and P_{ref} (as in the report). As no noticeable

differences were experienced between the two types of results, only the type-1 (*G*) results were analyzed in detail.

Dr Beißner commented that the radiation force balance was the preferred device used to perform these measurements. His report also included analysis of the stability of the device used. Nine institutes participated in the comparison. Unfortunately, two participants could not perform all the measurements.

Dr Beißner reported that he had used the weighted mean to calculate the KCRVs. At the time that the report was compiled, Dr Beißner was not aware of the BIPM guidance document, so the document's recommendations had not been followed specifically. The mean values calculated were verified for robustness and results that did not comply with the criteria were recalculated using the median.

Dr Filliben reopened the debate concerning the use of the weighted mean to calculate the KCRV. However, it was noted that consensus had been reached at the previous CCAUV meeting, that where possible the weighted mean would be used to calculate the KCRV.

It was noted that the participants' uncertainty budgets as well as the weighting factors used to calculate the weighted mean values should be included in the report. The report was accepted as the final report.

3.6 CCAUV.U-K2

Dr Zeqiri's report (CCAUV/02-26) on the CCAUV.U-K2 comparison highlighted that the results of only four of the seven original participants were included in the report. The other three laboratories were excluded on the basis that they did not realize the standard at a primary level.

Dr Zeqiri mentioned that the results of one laboratory were identified as outliers. The laboratory had submitted new results at the time that the Draft A report was discussed. All participants at the 2nd meeting of the CCAUV agreed upon the inclusion of the new results. Prof. Wallard confirmed that this was acceptable.

With reference to results that need to be considered as outliers, it was agreed that these should not be included in the calculation of the reference value, but should be included in the report and degrees of equivalence. It was noted that when results are not included in the calculation of the reference values, this needs to be stated clearly in the report.

It was agreed that the outlier results identified should be included in the degrees of equivalence (matrices and graphs). The exclusion of the outliers from the calculation of the reference value will be included in the report. The final report will be completed after the bilateral comparison between the NIM and the NPL, scheduled for the first half of 2003, has been completed and will be circulated by e-mail for approval by the CCAUV.