

TECHNICAL PROTOCOL FOR EURAMET COMPARISON EURAMET.AUV.A-S2



1. Reference Number: <i>(please leave blank)</i>	2. Technical Committee: TC-AUV	
3. Project Title: Comparison of secondary free-field calibration of WS2 microphones (EURAMET.AUV.A-S2)		
4. Proposed start date: February 2014	Proposed end date:	Project Duration (months):
5. Coordinating institute & coordinator contact details: Laboratoire National de métrologie et d'Essais 29 avenue Roger Hennequin 78197 Trappes Cedex France Dominique.rodriques@lne.fr +33(0)130691487		

Summary of Participation in Work Packages

WP No	Work Package Name	Active Partners (Institutes; WP Leader in Bold)
WP1	Measurement phase	BEV (Austria), DFM (Denmark), INRiM (Italy), INMETRO (Brazil), LNE (France) , NPL (UK), PTB (Germany)
WP2	Draft A	LNE (France)
WP3	Draft B	LNE (France)
WP4	IMPACT: exploitation, dissemination and knowledge transfer	LNE (France)

Project Description

A – Introduction and Projected Impact.

Currently, the reciprocity method is the favoured primary technique for calibration of Laboratory Standard (LS) microphones. For economical reasons, secondary methods are generally preferred for the calibration of Working Standard microphones. When a calibrated reference microphone and a test microphone are exposed to the same sound pressure, either simultaneously (comparison method) or sequentially (substitution method), and under the same environmental conditions, then the sensitivity of the test microphone can be calculated from the known sensitivity of the reference microphone. Secondary methods are operational for several years for pressure calibrations unlike to free-field calibrations for which the capabilities of NMIs are more recent.

Recently, the Working Group 05 “Measurement microphones” of the IEC Technical Committee 29 worked on a new standard IEC 61094-8 “Measurement microphones - Part 8: Methods for determining the free-field sensitivity of working standard microphones by comparison”. It was published in 2012 and some NMIs worked to set up calibration facilities in accordance with this new standard.

It was agreed during the annual meeting of EURAMET’s TC-AUV in Trappes (France) on May 2012 that a comparison on secondary free-field calibration of WS microphones would be carried out. The TC-AUV decided an outline for a regional Supplementary Comparison and it was agreed that LNE would be the pilot laboratory.

This document defines the protocol for the comparison. It should be read in conjunction with the “Guidelines for key comparisons carried out by Consultative Committees” by T J Quinn which includes more details on the purpose and conduct of key comparisons in general. The purpose of this document is to “specify the procedures necessary for the comparison, but not the procedures used for the realization of the standards being compared.”

B – Scientific and Technological Frame and Objectives.

This comparison is only concerned with secondary free-field methods of calibration, particularly the methods described in the International Standard IEC 61094-8 (2012), and will only consider results from such methods.

The microphones require a polarising voltage of 200 V.

Table 1: Scope of the comparison.

Frequency range	Sensitivity level
25 Hz – 500 Hz	Optional
500 Hz – 20 kHz	Mandatory
20 kHz – 40 kHz	Optional

Table 1 shows the measurand and frequency ranges within the scope of the comparison. Participants shall complete at least the mandatory element; the optional elements can be covered partially. Each laboratory is to report the open-circuit free-field sensitivity level in the reference direction of both microphones without their protection grid at third-octave frequencies.

The open circuit free-field sensitivity level shall be reported in decibels with a reference value of 1V/Pa.

It is the IEC TC29 policy that specifications referring to frequency in all new or revised standards, use the base 10 system of frequencies specified in IEC 61260. It is therefore appropriate to adopt this policy for this comparison. Accordingly measurements shall be carried out and reported at frequencies generated by the formulae given below. In all calculations, the reference frequency f_r is 1000 Hz (NB. The octave frequency ratio of $G = 10^{3/10}$ described in IEC 61260, is implicit in this equation).

The third-octave calibration frequencies f_n between 25 Hz and 40 KHz shall be calculated from:

$$f_n = f_r 10^{n/10}, \quad (1)$$

where n is an integer between -16 and 16 .

The actual frequency than can be set during a measurement will be determined by the particular equipment used. The effect of any significant variation in the set frequency from that calculated above, on the measured sensitivity level shall be accounted for in the uncertainty analysis.

Any other frequencies (for example, preferred nominal frequencies) reported by the participants will not be collated by the pilot laboratory.

C - Description of the work.

Two WS2 microphones have been selected for this comparison. The microphones are Brüel & Kjær type 4191 serial numbers 2114351 and 2114352. Each participant is responsible for the collection and return of the microphones to LNE. Local customs formalities must be observed and if the participating laboratory requires LNE to supply an ATA carnet for this purpose (or any other documentation) then they must give sufficient notice for LNE to obtain that documentation. The timetable must be followed regardless of any delays caused by customs irregularities and this could cause a laboratory to lose the opportunity to participate in the comparison.

The microphones may be transported either by a courier company like DHL or by hand. If a courier company is chosen the microphones will be put in a thermo-jug packed in an isolated box delivered by LNE. The microphones shall be returned using the same packing. If the microphones are transported by hand the microphones will be packed into the small box as provided by the manufacturer in order to avoid 'check-in' problems during travelling. In this situation the microphones shall be carried only in the passenger cabin and never in the hold of an aircraft. No packaging will be supplied beyond that provided by the manufacturer of the microphones as it is thought that the best protection is the vigilance of the person carrying the microphones and this is easier to achieve when the package is small.

Large temperature changes and sudden shocks must be avoided as these could cause an irreversible change in sensitivity or for the microphones to become less stable. Sudden shocks can be caused by applying sound calibrators, pistonphones or dehumidifiers to the microphones and these actions should also be avoided or performed with great care.

The microphones must not be used for any purposes other than those associated with their calibration for this comparison.

C1 – WP1: Measurement Phase - LNE

C1a: Description of work

Pre-participation

The comparison is scheduled to begin on 1 February 2014, when the pilot laboratory will start their measurements. The microphones will then be circulated to other participants for the first time.

Prior to the circulation of the microphones, participants shall complete the 'Agreement to participate form' shown in Annex 2. This includes a statement of the measurements they expect to carry out and report. An electronic version of this form has been circulated with this protocol.

Reporting Results

Each laboratory shall report their results using the standard certificate that they would issue to a customer. However results shall also reported in the pilot laboratory's proforma spreadsheet that has been circulated with the protocol. The consistency between the results in electronic form and the printed and signed calibration report is the responsibility of the participating laboratory.

It is admitted that there are not reliable coefficients to correct effects of static pressure and temperature on free-field sensitivities of the microphones B&K 4191. Therefore, it is strongly recommended to perform the measurements at environmental conditions near to the reference ones given in the standard IEC 61094-8:2012, especially for the temperature that can be easily controlled.

Results shall be reported at the actual environmental conditions.

Where necessary an additional covering letter or report shall be provided to include any details not covered in the certificate, including:

- Details of any deviations from the recommendations in IEC 61094-8 (2012) and an estimate of the effect on the reported results.
- The actual environmental conditions during the calibrations.
- The actual distance(s) used between the microphones and the sound source during the calibration.
- A summary of the uncertainty calculation, listing and quantifying each of the components considered, and indicating the method used to produce the overall estimate of measurement uncertainty.
- Calibration results using three decimals (if not already given in the certificate).
- A brief description of the
 - General principle (sequential or simultaneous excitation),
 - Test space,
 - Signal processing used to clean typical disturbances,
 - Sound source,
 - Reference microphone and its calibration method,
 - Test signal.

The final results and the accompanying information should be received at LNE within 4 weeks of the end of the scheduled measurement period. Dated deadlines can be found in the schedule shown in section E. A reminder will be sent by email one week before the due date and this deadline shall be strictly enforced. Failure on submitting the results within the deadline may lead to the exclusion of the participant laboratory.

The pilot laboratory will carry out their measurements at the start of the circulation period and their results shall be lodged with the CCAUV secretariat within 4 weeks of the end of their measurement period.

When all participants have completed the measurements, the data will be analysed by the pilot laboratory. If a result is found to be anomalous the laboratory in question will be notified and given 3 weeks to respond. A draft A report will then be prepared.

If the analysis with results at actual environmental conditions fails, the pilot laboratory will correct all results to the average environmental conditions using the polynomials for B&K 4191 microphones published in the B&K Technical Review, 2001.

Finance

Participants are responsible for their own costs, the cost of delivering the microphones to the next recipient, any ATA carnet required and for any damage to the microphones while they are in their possession.

Timetable

The timetable is given in Section E.

It is essential that the microphones return to LNE on time, even if measurements are not complete at the participating laboratory. If a problem arises with the timetable then it may be possible for two participants to exchange their place in the timetable.

If measurements cannot be completed at a laboratory then it may be possible for the microphones to go to that laboratory after the termination of the measurement round (in 2014). However LNE cannot guarantee to perform check measurements after this date.

In the event of one of the microphones failing then LNE will attempt to find a substitute though this may make the analysis of the results more complicated.

The microphones will return to LNE for a check pressure reciprocity calibration as established in the time schedule proposed for the comparison. This is so that the stability of the devices can be monitored and so that results from different laboratories can still be compared should a change occur.

C1b Total person months for this work package:

WP number	BEV	DFM	INRiM	INMETRO	LNE	NPL	PTB	TOTAL Σ
WP1	1	1	1	1	2	1	1	8

C1c: Deliverables List

WP number	Task	Deliverable description	Lead Partner	Other Partners	Delivery date
WP1	D1.1	Preparation phase – creation of protocol	LNE		October 2013
	D1.2	Registration with CCAUV and EURAMET	LNE	CCAUV, EURAMET	November 2013
	D1.3	Protocol KCWG circulation	LNE	KCWG	November 2013
	D1.4	Measurement phase	LNE	BEV, DFM, INRiM, INMETRO, NPL, PTB	February 2014 – December 2014

C2 – WP2: Draft A - LNE

C2a: Description of work

The pilot laboratory will undertake to analyse the microphone stability data and the data received from the participants. The preliminary results will then be communicated to the participants in the form of a Draft A report.

The determination of the Comparison Reference Values is an important outcome of this project. It is expected that the analysis of the results can be conducted in the same way as used for the key comparison CCAUV.A-K4.

C2b Total person months for this work package:

WP number	BEV	DFM	INRiM	INMETRO	LNE	NPL	PTB	TOTAL Σ
WP2	0	0	0	0	3	0	0	3

C2c: Deliverables List

WP number	Task	Deliverable description	Lead Partner	Other Partners	Delivery date
WP2	D2.1	Analysis of microphone stability data completed.	LNE		January 2015
	D2.2	Analysis of participants' measurement data completed.	LNE		March 2015
	D2.3	Draft A report written.	LNE		March 2015
	D2.4	Draft A report circulated and comments from participants received by LNE.	LNE	BEV, DFM, INRiM, INMETRO, NPL, PTB	March 2015

C3 – WP3: Draft B - LNE

C3a: Description of work

After receipt of comments on Draft A from the participants, the pilot laboratory shall produce further versions of Draft A (A1, A2... etc.) until the report is approved by all the participants and is renamed 'Draft B Report'. These later drafts may contain a more sophisticated statistical analysis of the data, than the original Draft A. Draft B shall then be circulated to the WG and then the CC for their approval, before being renamed as the 'Final report'.

C3b Total person months for this work package:

WP number	BEV	DFM	INRiM	INMETRO	LNE	NPL	PTB	TOTAL Σ
WP3	0.5	0.5	0.5	0.5	2	0.5	0.5	5

C3c: Deliverables List

WP number	Task	Deliverable description	Lead Partner	Other Partners	Delivery date
WP3	D3.1	Draft A1	LNE		March 2015
	D3.2	Circulation of Draft A1	LNE	BEV, DFM, INRiM, INMETRO, NPL, PTB	April 2015
	D3.3	Draft A2 (Note this is an iterative process and may require additional versions)	LNE	BEV, DFM, INRiM, INMETRO, NPL, PTB	May 2015
	D3.4	Circulation of Draft B	LNE	KCWG, CCAUV	June 2015
	D3.5	Finalisation of report	LNE	KCWG, CCAUV	July 2015

C4 – WP4: Dissemination, Exploitation and Knowledge Transfer activities - LNE

C4a: Description of work

Transfer of the KCRV and/or KCRC to the KCDB. Publication of the final report.

C4b Total person months for this work package:

WP number	LNE/BIPM	TOTAL Σ
WP4	1	1

C4c: Deliverables List

WP number	Task	Deliverable description	Lead Partner	Other Partners	Delivery date
WP4	D4.1	Publication of the final report.	LNE		July 2015
	D4.2	Liaison with BIPM to publish KCRVs/KCRC and degrees of equivalence in the KCDB.	LNE	BIPM	July 2015

D – Summary deliverable list

WP number	Deliverable number	Deliverable description	Lead Partner	Other Partners	Delivery date
WP1	D1.1	Preparation phase – creation of protocol	LNE		October 2013
	D1.2	Registration with CCAUV and EURAMET	LNE	CCAUV, EURAMET	November 2013
	D1.3	Protocol KCWG circulation	LNE	KCWG	November 2013
	D1.4	Measurement phase	LNE	BEV, DFM, INRiM, INMETRO, NPL, PTB	February 2014 – December 2014
WP2	D2.1	Analysis of microphone stability data completed.	LNE		January 2015
	D2.2	Analysis of participants' measurement data completed.	LNE		March 2015
	D2.3	Draft A report written.	LNE		March 2015
	D2.4	Draft A report circulated and comments from participants received by LNE.	LNE	BEV, DFM, INRiM, INMETRO, NPL, PTB	March 2015
WP3	D3.1	Draft A1	LNE		March 2015
	D3.2	Circulation of Draft A1	LNE	BEV, DFM, INRiM, INMETRO, NPL, PTB	April 2015
	D3.3	Draft A2 (Note this is an iterative process and may require additional versions)	LNE	BEV, DFM, INRiM, INMETRO, NPL, PTB	May 2015
	D3.4	Circulation of Draft B	LNE	KCWG, CCAUV	June 2015
	D3.5	Finalisation of report	LNE	KCWG, CCAUV	July 2015
WP4	D4.1	Publication of the final report.	LNE		July 2015
	D4.2	Liaison with BIPM to publish KCRVs/KCRC and degrees of equivalence in the KCDB.	LNE	BIPM	July 2015

F –Project Resources

F1 - Summary of labour resources per work package in person months

Work package	Institute							
	BEV	DFM	INRiM	INMETRO	LNE	NPL	PTB	TOTAL
WP1	1	1	1	1	2	1	1	7
WP2	0	0	0	0	3	0	0	3
WP3	0.5	0.5	0.5	0.5	2	0.5	0.5	4.5
WP4	0	0	0	0	1	0	0	1
TOTAL person months	1.5	1.5	1.5	1.5	8	1.5	1.5	15.5

Annex 1: Contact Details

Institute	Contact Name	Address	Tel	Fax	e-mail	Notes
BEV	Christian Zimmerman	BEV-Bundesamt für Eich-und Vermessungswesen Leiter des Labors E131-Akustik und Vibration 1160 Wien, Arltgasse 35	+ 43 1 21110-6329		Christian.Zimmermann@bev.gv.at	
DFM	Salvador Barrera-Figueroa	Danish Fundamental Metrology Matematiktorvet 307 DK-2800 Kongens Lyngby Denmark			sbf@dfm.dtu.dk	
INRIM	Claudio Gugliemone	Istituto Nazionale di Ricerca Metrologica Strada delle Cacce 91 IT-10135 Torino Italy	+39 011 3919626		c.gugliemone@inrim.it	
INMETRO	Zemar M. Defilippo Soares	Instituto Nacional de Metrologia, Normalização e Qualidade Industrial Av. N. Sra. Das Graças, 50 25250-020 Duque de Caixas, RJ Brazil	++5521267991 12		zmsoares@inmetro.gov.br	
LNE	Dominique Rodrigues	Laboratoire National de Métrologie et d'Essais rue Gaston Boissier 1 FR-75724 Paris cedex 15 France	+33(0)1306914 87	+33(0)130691 234	dominique.rodrigues@lne.fr	
NPL	Richard Barham	National Physical Laboratory Hampton Road GB-TW11 0LW Teddington, Middlesex United Kingdom	+44 20 8943 6706		Richard.Barham@npl.co.uk	
PTB	Thomas Fedtke	Physikalisch-Technische Bundesanstalt, Braunschweig Bundesallee 100 D-38116 Braunschweig	+49 531 592 1511 +49 174 6986502	+49 531 592 691511	Thomas.Fedtke@ptb.de	

Annex 2: Agreement to participate

Agreement to participate in EURAMET.XXX

Name and address of laboratory

Contact person

Name:

E-mail:

Phone:

Methodology

IEC 61094-8:2012

Other (please give details in Additional Information below)

Scope

Frequency range	Sensitivity level
25 Hz - 500 Hz (optional)	
500 Hz - 20 kHz (mandatory)	
20 kHz – 40 kHz (optional)	

Will you require an ATA Carnet? Yes No

The proposed date for participation is acceptable

Additional information (specify the frequency range covered for the optional elements)

[Please return this form to dominique.rodriques@lne.fr](mailto:dominique.rodriques@lne.fr)

The pilot laboratory has distributed this form electronically to participating laboratories. A further copy is available by contacting dominique.rodriques@lne.fr.