

EL CENTRO NACIONAL DE METROLOGÍA  
&  
DANISH FUNDAMENTAL METROLOGY,  
DANISH PRIMARY LABORATORY FOR ACOUSTICS

# TECHNICAL PROTOCOL FOR COMPARISON AMONG CENAM, DANIAmet-DFM, DMDM, AND INM.

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**Final Version**

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# TECHNICAL PROTOCOL FOR COMPARISON AMONG CENAM, DANIAm<sub>e</sub>t-DFM, DMDM, AND INM.

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## BACKGROUND

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It was agreed during the annual meeting of EURAMET's TC-AUV in Sofia, Bulgaria on May 2009 that a Comparison among CENAM (Mexico), DANIAm<sub>e</sub>t-DFM (Denmark), DMDM (Serbia), and INM (Romania) should be organised under the aegis of EURAMET. This comparison should be concerned with pressure calibration of laboratory standard microphones LS1P and LS2aP. Discussions during the TC-AUV conducted to an outline for the comparison and it was agreed that DANIAm<sub>e</sub>t-DFM would perform the control measurements, and CENAM would be the laboratory analysing the data. CENAM would receive technical assistance from DANIAm<sub>e</sub>t-DFM if necessary.

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."

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## PARTICIPANTS

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The following laboratories will participate:

- ◆ CENAM, Mexico
- ◆ DANIAm<sub>e</sub>t-DFM, Denmark
- ◆ DMDM, Serbia
- ◆ INM, Romania

Contact details are listed at the end of the protocol.

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## MICROPHONES TO BE CIRCULATED

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Two LS1P microphones Brüel & Kjær type 4160 and two LS2aP microphones Brüel & Kjær type 4180 have been selected for this comparison.

Each participant is responsible for the collection and return of the microphones to DANIAm<sub>e</sub>t-DFM. Local customs formalities must be observed and if the participating laboratory requires DANIAm<sub>e</sub>t-DFM to supply an ATA carnet for this purpose (or any other documentation) then they must give sufficient notice for DANIAm<sub>e</sub>t-DFM 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 DANIAm<sub>e</sub>t-DFM. 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.

The microphones will return to DANIAMet-DFM for a check 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.

## MEASUREMENTS

This comparison is only concerned with primary methods of calibration, particularly the method described in the International Standard IEC 61094-2 (2009), and will only consider results from such methods.

Calibrations must be made in air. Calibrations in other gasses (such as Hydrogen) are **NOT** allowed.

The microphones require a polarising voltage of 200 V.

Each laboratory is to report the open-circuit pressure sensitivity level of both microphones at the **exact** 1/3<sup>rd</sup>-octave centre frequencies from 31,5 Hz to 12,5 kHz for LS1 microphones, and from 31,5 Hz to 31,5 kHz for LS2 microphones using their normal primary calibration method. These frequencies are chosen in order to comply with the harmonisation proposed jointly by ISO and IEC. **The exact frequencies can be calculated using the formula in section 3.1 of the International Standard ISO 266 (1997).** The table below contains the calculated frequencies rounded to five significant digits, and is presented for informative purposes only. It is important to emphasize that the exact frequencies must be used in the measurements.

**Table 1. Values of the calculated frequencies (in Hz) using the formula in 3.1 of ISO 266, rounded to 5 significant digits**

31,623	100,00	316,23	1000,0	3162,3	10000	31623
39,811	125,89	398,11	1258,9	3981,1	12589	
50,119	158,49	501,19	1584,9	5011,9	15849	
63,096	199,53	630,96	1995,3	6309,6	19953	
79,433	251,19	794,33	2511,9	7943,3	25119	

Control calibrations at the pilot laboratory will be conducted in the full frequency range.

**The microphones submitted shall only be used as receivers.**

**Additionally, the use of vacuum grease on the front rings of the microphones is STRICTLY prohibited.**

Results shall be corrected to the reference environmental conditions given in IEC 61094-2, 2009.

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## REPORTING RESULTS

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Each laboratory shall report their results using the standard certificate that they would issue to a customer. This certificate should include:

- The actual environmental conditions during the calibrations.
- Values of the temperature and pressure coefficients of the microphones used in the calculations.
- Values of the microphone parameters used in the calculations: equivalent volume, front volume, resonance frequency, and loss factor.
- A summary of the uncertainty calculation and the overall uncertainties calculated for a coverage factor of  $k=2$ . It must be noticed that the CIPM Guidelines require uncertainty budgets to be submitted in advance of participation. Each laboratory shall submit a sufficiently detailed uncertainty budget and failure on doing so may result in the exclusion of the laboratory. The (preliminary) budget shall be submitted before the comparison starts. However, any changes will be accepted, provided they are submitted **before** the laboratory receives the microphones and carries out the measurements.

An additional covering letter or report should include (where necessary):

- Details of any deviations from the recommendations in IEC 61094-2 (2009) and an estimate of the effect on the reported results.
- The values of the acoustic parameters of the microphones: equivalent volume, front volume, resonance frequency, and loss factor (if not already included in the certificate).
- Calibration results using three decimals (if not already given in the certificate).

The results should be posted to DANIAmet-DFM within a maximum of four weeks of the return of the microphones. This deadline shall be strictly enforced. Failure on submitting the results within the deadline may lead to the exclusion of the participant laboratory. An email or fax should be sent to announce that the results have been despatched. When all participants have finished the measurements, the reports together with the results from DANIAmet-DFM will be submitted to CENAM for analysis. If a result is found anomalous the laboratory in question will be notified and given 3 weeks to respond. Results from DANIAmet-DFM will then be circulated to the participants and the pilot laboratory will prepare a first draft report.

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## FINANCE

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Participants are responsible for their own costs, i.e. issuing an ATA carnet if necessary, the collection and return of the microphones and for any damage to the microphones while they are away from DANIAmet-DFM. If the microphones will be transported by a courier company the participant shall contact the courier company and arrange for the microphones to be picked up at DPLA. In case DHL or UPS are used the laboratory may inform DANIAmet-DFM on their relevant import account number and full receiver address of the laboratory. DANIAmet-DFM will then contact the company and ask for a pick-up.

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## COMPARISON REFERENCE VALUE

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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-K3 and CCAUV.A-K4.

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## TIMETABLE

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The timetable is shown below. It is essential that the microphones return to DANIAmet-DFM 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 2010). However DANIAmet-DFM cannot guarantee to perform check measurements after this date.

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

No	Calibration laboratory	Starting date	Finishing date
1	DANIAmet-DFM	June 29 <sup>th</sup> , 2009	July 31 <sup>st</sup> , 2009
2	DMDM	August 3 <sup>rd</sup> 2009	September 11 <sup>th</sup> , 2009
3	INM	September 14 <sup>th</sup> , 2009	October 23 <sup>rd</sup> , 2009
4	DANIAmet-DFM	October 26 <sup>th</sup> , 2009	November 6 <sup>th</sup> , 2009
5	CENAM	November 9 <sup>th</sup> , 2009	December 18 <sup>th</sup> , 2009
6	DANIAmet-DFM	December 21 <sup>st</sup> , 2009	January 29 <sup>th</sup> , 2010

## List of contact persons

<p><b>CENAM:</b>            Andrés Esteban Pérez Matzumoto            Centro Nacional de Metrología            Vibration and Acoustics Division            Km 4,5 Carretera a Los Cués, Municipio El Marqués            C.P. 76241 Querétaro            Mexico            Tel: -52 442 211 0500            Fax: +52 442 211 0553            Email: <a href="mailto:eperez@cenam.mx">eperez@cenam.mx</a></p>	<p><b>DMDM:</b>            Maja Aleksić            Directorate of Measures and Precious Metals            Mike Alasa 14            RS-11 000 Beograd            Serbia              Tel: +381 11 20 24 418            Fax: +381 11 21 81 668            E-Mail: <a href="mailto:maja@dmdm.rs">maja@dmdm.rs</a></p>
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