THE CENTRAL OFFICE OF MEASURES

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| TECHNICAL PROTOCOL  FOR COOMET COMPARISON  COOMET.AUV.A-K5 |

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## INTRODUCTION

The State Enterprise Scientific-Research Institute for Metrology of  Measurement and Control Systems (DP NDI Systema) - National Metrology Institute in Ukraine in the field of acoustics has forwarded to the Central Office of Measures (GUM) the request for bilateral comparison concerning the pressure calibration of laboratory standard microphones type LS1P to be piloted by the GUM.

The DP NDI Systema took part in the COOMET.AUV.A-K1 comparison with the results linked to the first CIPM comparison CCAUV.A-K1 concerning pressure calibration of LS1P microphones. In 2013 the second key comparison CCAUV.A-K5 was completed. The scope of this comparison was expanded significantly compared with the CCAUV.A-K1. The GUM participated in the CCAUV.A-K5 and is hence in the position to provide linking to other institutes.

The comparison has been registered as COOMET subsequent key comparison and denoted COOMET.AUV.A-K5. It is intended to disseminate the KCRV established in CCAUV.A-K5 comparison to the DP NDI Systema.

Subsequent comparisons are required to follow the same technical protocol as their CIPM comparisons. This document outlines the protocol for bilateral subsequent comparison with the GUM as a pilot and follows the Technical Protocol for the CCAUV.A-K5. It should be read with conjunction with the CIPM MRA-D-05 document. 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.

## PARTICIPANTS

The following laboratories are the participants of this bilateral comparison:

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| Central Office of Measures (GUM) - pilot | Danuta Dobrowolska  00-139 Warsaw  Elektoralna 2  Poland  Phone: + 48 22 581 91 36  Fax: + 48 22 581 93 88  E-mail: [d.dobrowolska@gum.gov.pl](mailto:d.dobrowolska@gum.gov.pl) |
| The State Enterprise Scientific-Research Institute for Metrology of  Measurement and Control Systems (DP NDI Systema) | Alexander Kosterov  6 Kryvonosa Str.  79008 Lviv  Ukraine  Phone: +38 0322 39 92 23  Eax: +38 0322 35 84 49  E-mail: [Kosterov@dndi-systema.lviv.ua](mailto:Kosterov@dndi-systema.lviv.ua) |

## MICROPHONES TO BE CIRCULATED

One LS1P microphone Brüel & Kjær type 4160 serial number 2545015 has been selected for this comparison. This microphone is referred to as the reference microphone in the remainder of this document. Additional microphone will be maintained by the pilot laboratory should the reference microphone fail during the key comparison.

Each participant is responsible for transporting the reference microphone to the next participant according to a schedule and using air courier. Local customs formalities must be observed and if the participating laboratory requires GUM to supply an ATA carnet (or any other documentation) for this purpose, they must inform GUM about that.

The reference microphone will be packaged in a suitable form for transportation by courier. The microphone shall be stored appropriately while in the possession of the participating laboratory. Ideally this should be in temperature controlled environment maintained at the reference temperature of 23°C. Any protection grid fitted to the microphones for transportation, shall be removed before conducting measurements.

The microphone case will be marked as key comparison reference standard and the microphone must not be used for any purpose other than that associated with its calibration for this comparison. Sudden shocks can be caused by applying sound calibrators, pistonphones or dehumidifiers to the microphone and these actions should also be avoided.

## MEASUREMENTS

This comparison is concerned with primary method of calibration of microphones, e.g. the reciprocity method according to IEC 61094-2:2009.

The reference microphone requires a polarising voltage of 200 V. **No grease will be allowed to be used with the reference microphone**. The reference microphone has suitably flat front surface to make the use of grease on the contact surface unnecessary for couplers filled with air. The use of hydrogen-filled couplers is not recommended. Any protection grid fitted to the microphone shall be removed before conducting measurements.

The scope of the comparison comprises determination of the open-circuit pressure sensitivity level and the open-circuit pressure sensitivity phase of the reference microphone. Measurements shall be performed at 1/3-octave frequencies in the range from 2 Hz to 10 kHz.

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

The convention to be used for reporting the sensitivity phase is that it approaches 180º at low frequency and is 90º at the resonance frequency of the microphone, i.e. the sensitivity phase shall be reported as positive values.

Measurements shall be carried out and reported at frequencies generated by the formulae given below. In all calculations, the reference frequency *fr* is 1000 Hz (NB. the octave frequency ratio of *G* = 10(3/10) described in IEC 61260, is implicit in these equations). In the whole frequency region the third-octave calibration frequencies *fn* between 2 Hz to 10 kHz shall be calculated from:

*fn = f*r10*n*/10

where *n* is an integer between –27 and 10.

The actual frequency that 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.

## REPORTING RESULTS

Each laboratory shall report their results using the standard certificate that they would normally issue to a customer. However results shall also be reported in the pilot laboratory’s spreadsheet template, that has been circulated with this protocol. Please remember to **check the box confirming that the data reported in the spreadsheet template is consistent with that reported in the certificates**, as the spreadsheet data will be used as the basis for the analysis.

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

Results shall be accompanied by a statement of the associated measurement uncertainty, estimated for a confidence probability of 95%.

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 61094-2 and an estimate of the affect this has on the reported results.
* The values of the front cavity volume, cavity depth, and microphone acoustic impedance parameters used in the calculation, where appropriate.
* Values of the temperature and static pressure coefficients of the microphone used in the calculations.
* 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.
* A brief description of the measurement system used.

The pilot laboratory will carry out the measurements at the start of the circulation period and the results shall be lodged with the CCAUV secretariat before sending the reference microphone to the DP NDI Systema.

The final measurement results of DP NDI Systema should be submitted both to the GUM and to the CCAUV secretariat within four weeks of the end of the scheduled measurement period.

Dated deadline can be found in the schedule shown in the Timetable presented in the next part of this protocol. An email to the pilot laboratory should be sent to announce that the results have been despatched. The completed spreadsheet template should be attached to this email. It is also acceptable to send all other material by email, but hardcopy of calibration certificate should follow in the post.

When both participants have completed the measurements, the data will be analysed by the pilot laboratory. If a result is found to be anomalous the participating laboratory will be notified and given two weeks to respond. A Draft A report will then be prepared.

## FINANCE

Participants are responsible for their own costs, the cost of delivering the microphone to the next recipient, any cost (if applicable) relating to custom clearing of the reference microphone and for any damage to the microphone while it is in their possession.

## TIMETABLE

According to the timetable below the comparison is scheduled to begin on 12 October 2015 when the pilot laboratorywill start the measurements. The DP NDI Systema has been allocated a 4-week period in the schedule. The first three weeks should be used to acclimatise the reference microphones to the laboratory environment and to carry out measurements. During the fourth week, the laboratory must finalise their measurements and despatched the microphone to the to the GUM for subsequent calibration so that its stability could be monitored.

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| NMI | Country | Receipt of a microphone | October  week | | | November  week | | | | December  week | | |
| 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 |
| GUM | Poland | 12-Oct-2015 |  |  |  |  |  |  |  |  |  |  |
| Courier | | |  |  |  |  |  |  |  |  |  |  |
| DP NDI Systema | Ukraine | 9-Nov-2015 |  |  |  |  |  |  |  |  |  |  |
| Courier | | |  |  |  |  |  |  |  |  |  |  |
| GUM | Poland | 7-Dec-2015 |  |  |  |  |  |  |  |  |  |  |

## LINKING

The results of the DP NDI Systema obtained in this comparison will be linked to the CCAUV.A-K5 key comparison through the joint participation of the GUM. The degrees of equivalence will be computed for Ukraine with respect to the CCAUV.A-K5 Key Comparison Reference Value.