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TECHNICAL PROTOCOL FOR SUPPLEMENTARY COMPARISON COOMET.AUV.A-S4

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BACKGROUND

The decision to organize supplementary comparison on calibration of sound calibrators was made at the 13th meeting of the COOMET Technical Committee TC 1.2 that took place in Istanbul (Turkey) in September 2018. Following the decision from the meeting the comparison was registered as COOMET project 790/TR/19 on the COOMET database.

The objective of the current supplementary comparison is to prove and validate the calibration and measurement capabilities of the NMIs/DIs participating in the comparison for calibration of single frequency sound calibrators corresponding to the service category 2.1.1 according to the "Classification of services in Acoustics, Ultrasound and Vibration" published on the BIPM website [1].

It was decided to carry out comparison with sound calibrators operating at different frequencies and to provide technical evidence for validation of related calibration capabilities. The scope of comparison includes measurement of sound pressure level generated by calibrators as mandatory quantity, while measurements of operating frequency and distortion are optional, and results of these measurements will be used for investigation purpose only.

It was agreed that the National Metrology Institute of Turkey (TÜBİTAK UME) will act as the pilot laboratory in the supplementary comparison and will provide the circulating artefacts to be calibrated by each participant.

The Technical Protocol was drawn up in accordance with COOMET R/GM/11:2017 recommendation [2] that is based on provisions of "CIPM MRA-G-11" document [3]. The aim of this document is to describe the requirements for comparison in detail, but it does not concern with procedures applied by participants for comparison.

PARTICIPANTS

The following laboratories will participate in the comparison.

- BelGIM, Belarus
- BFKH, Hungary
- DP NDI "Systema", Ukraine
- NSAI NML, Ireland
- SASO NMCC, Saudi Arabia
- TÜBİTAK UME, Turkey
- NMS, Lithuania
- VNIIFTRI, Russia

Contact details are presented in Annex 1.

SOUND CALIBRATORS TO BE CIRCULATED

Two standards have been selected for this comparison. They are Brüel & Kjær type 4228 pistonphone with serial number 1578522 and Brüel & Kjaer type 4231 sound calibrator with serial number 3011731. These standards are referred to as the sound calibrators in this document. Additional sound calibrators will be maintained by the pilot laboratory should any calibrator fail during the supplementary comparison.

Each participant is responsible for transporting the sound calibrators to its laboratory and back to pilot laboratory according to the time schedule of the comparison. The supplementary comparison is scheduled to begin on **15 January 2022**, when the pilot laboratory will start their measurements. The sound calibrators will then be circulated to other participants for the first time.

Prior to the circulation of the sound calibrators, participants shall complete the 'Agreement to participate form' presented in Annex 3. 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.

Local customs formalities must be observed and if the participating laboratory requires TÜBİTAK UME to supply an ATA carnet (or any other documentation) for this purpose, they must inform the pilot laboratory, using the "Agreement to participate form".

The sound calibrators will be packaged in a suitable form for transportation by courier. It is essential that this packaging is used when using air or land couriers to transport the sound calibrators during their circulation from pilot laboratory to participant and back. The sound calibrators may also be hand carried, but it is recommended that the same packaging be used. The sound calibrators 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.

The sound calibrators cases will be marked as supplementary comparison reference standards and the sound calibrators must not be used for any purpose other than that associated with their calibration for this comparison.

Upon arrival of the artefact, the participant is requested to check if any damage has occurred to the protective package or to the sound calibrators during transportation. If any damage is observed, the participant shall contact the pilot laboratory immediately. Each participant must use new batteries for calibrations. After calibration is concluded, the batteries must be removed from the sound calibrators before their re-packing and transportation to the pilot laboratory.

MEASUREMENT METHODOLOGY

Each participant shall determine the sound pressure level generated by the pistonphone and sound calibrator according to the international standard IEC 60942:2017 [4]. The generated sound pressure level shall be measured by the microphone method (insert voltage technique) using calibrated measurement microphones. As IEC 60942 standard allows use of different microphones for calibration of sound calibrators (see clause 5.8.1 of the standard), the participants are free to use any microphone as specified in the standard. However, preferable configuration is using LS1P microphone for pistonphone and LS2P microphone for sound calibrator. The abbreviations for microphones are stated in accordance with the international standard IEC 61094-1 [5]. The one-inch to half-inch adaptor Brüel & Kjaer type DP 0776 will be circulated to participants together with the pistonphone. If any of participants uses WS2P type microphone, it would also be accepted.

The type of microphone used for calibration shall be reported by participant. If laboratory performed measurements for pistonphone with both LS1P and LS2P microphones, then it should be clearly stated which

result shall be considered as the result to be used for calculation of comparison reference value. The other result will be included in comparison report for information purpose only.

Results shall be corrected for the reference environmental conditions specified in IEC 60942:2017 (air temperature: 23 ºC, static pressure: 101,325 kPa and relative humidity: 50 %rh). The result for pistonphone shall be reported as corrected to load volume value of 1.333 cm^3 [6].

The microphone's temperature and pressure coefficients to be used are at the discretion of the participant. Thus, a participant can choose to use only the nominal known coefficients at 250 Hz, or a polynomial based coefficient at each frequency of interest [7]. Regardless of which method is chosen, it should be reported which method was used.

Further to measurements of sound pressure generated by the calibrators each participant could measure and report the additional information on operating frequency of the sound calibrators, total distortion + noise in percent (measured over a bandwidth of 22.4 Hz to 22.4 kHz) [4]. These additional measurements are not mandatory and results will be used for investigation purpose only.

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 proforma spreadsheet, that has been circulated with this protocol. Please remember to **check the box confirming that the data reported in the proforma spreadsheet is consistent with that reported in the certificates**, as the spreadsheet data will be used as the basis for the analysis.

The following information shall be reported for both sound calibrators:

- Sound pressure level generated by the sound calibrator (mandatory)
- Frequency (optional)
- Total distortion + noise (optional)

The reported value for sound pressure level shall be corrected to reference environmental conditions and effective loading volume specified in the section "Measurement Methodology".

If the participant measures the total distortion + noise, the reported result shall clearly state which method of measurement was used, i.e. using a rejection filter device (distortion factor meter) or an appropriate FFT analyzer.

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 measurement system used for calibration of sound calibrators.
- Values of the temperature and static pressure coefficients of the sound calibrators used in the calculations.
- Values of the temperature and static pressure coefficients of the microphones 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.

The final results and the accompanying information should be received at TÜBİTAK UME within **four weeks** of the end of the scheduled measurement period. Dated deadlines can be found in the schedule shown in Annex 2. A reminder will be sent by email one week before the due date and this deadline shall be strictly enforced: failure to submit results by the deadline may result in the exclusion of the participant laboratory. An email to the pilot laboratory should be sent to announce that the results have been despatched. The completed proforma spreadsheet should be attached to this email. It is also acceptable to send all other material by email to meet the deadline, but hardcopies of calibration certificates should follow in the post.

The pilot laboratory will carry out their measurements at the start of the circulation period and the results lodged with the CCAUV Executive Secretary.

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 **three weeks** to respond. A Draft A report will then be prepared.

FINANCE

Participants are responsible for their own costs, the cost of delivering the sound calibrators to their laboratory and back to pilot laboratory, any ATA carnet required and for any damage to the sound calibrators while they are in their possession.

TIMETABLE

The timetable is presented in Annex 2.

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. If measurements cannot be completed at a laboratory then it may be possible for the sound calibrators to go to that laboratory after the termination of the measurement round. However, TÜBİTAK UME cannot guarantee to perform check measurements after this date.

Each participating laboratory has been allocated a 5-week period in the schedule. The first three weeks should be used to acclimatise the sound calibrators to their laboratory environment and to carry out measurements. During the fourth week, the participating laboratory must finalise their measurements and despatched the sound calibrators back to the pilot laboratory. It is essential that the calibrators are passed on to the pilot laboratory on time even if measurements are not complete. If an individual laboratory has difficulty with their allocated time, it may be possible for two participants to exchange their place in the timetable. Two week time slot out of 5 weeks is allocated for transportation of the sound calibrators after each measurement cycle.

The sound calibrators will return to the pilot laboratory for an interim calibration, after calibration made by each participating laboratory. 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.

In the event of one of the sound calibrators failing then TÜBİTAK UME will find a substitute, though this may make the analysis of the results more complicated.

SUPPLEMENTARY COMPARISON REFERENCE VALUE

The determination of the Comparison Reference Values (CRV) is an important outcome of this project. The preliminary approach can be taken whereby the CRVs are determined as the weighted mean of results reported by the participants. The results reported by VMC (Lithuania) will not be considered for the evaluation of the CRVs as the laboratory is not neither NMI nor DI within the framework of CIPM MRA. However, the results reported by VMC will be included in the report for information purpose.

REFERENCES

1. Classification of Services in Acoustics, Ultrasound, Vibration (Last update June 2018), www.bipm.org
2. Recommendation of COOMET R/GM/11:2017 "Provision about the comparison of standards of the NMI of COOMET", https://www.coomet.net/publications/recommendations
3. Measurement comparisons in the CIPM MRA, Guidelines for organizing, participating and reporting CIPM MRA-G-11, version 1.1, 18.01.2021, www.bipm.org
4. IEC 60942, Electroacoustics - Sound calibrators, International Electrotechnical Commission, Geneva, 2017
5. IEC 61094-1, Measurement microphones - Part 1: Specifications for laboratory standard microphones, International Electrotechnical Commission, Geneva, 2000
6. Pistonphone Type 4228, Product Data, BP 0881-13, Brüel & Kjaer, https://www.bksv.com
7. Rasmussen K., The Influence of Environmental Conditions on the Pressure Sensitivity of Measurement Microphones, Brüel & Kjaer, Technical Review No.1, 2001, pp. 1-13

ANNEX 1. CONTACT DETAILS

Valentina Pozdeeva Belarussian State Institute of Metrology (BelGIM) 93, Starovilensky trakt, Minsk, BY-220053, Belarus Phone: +375 17 324 37 35 Fax: +375 17 244 99 38 e-mail: pozdeeva@belgim.by	George Lelovics Government Office of the Capital City Budapest (BFKH) H-1124 Budapest, Németvölgyi út 37-39, Hungary Phone: +36 1 45 85 873 Fax: +36 1 45 85 927 e-mail: lelovics.gyorgy@bfkh.gov.hu
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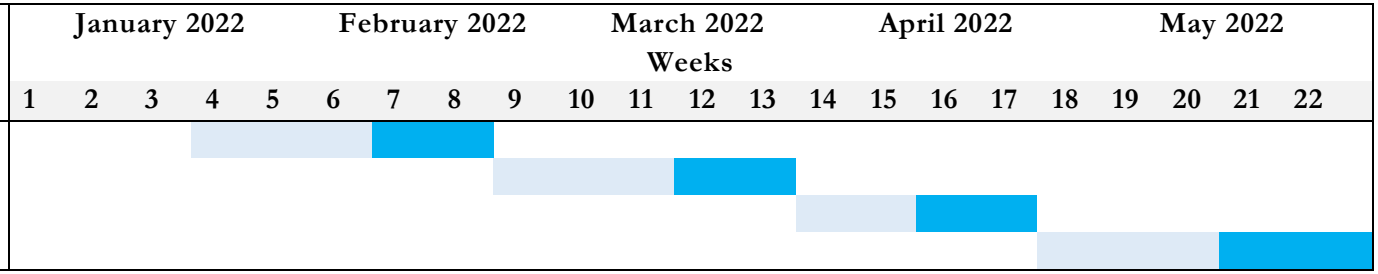
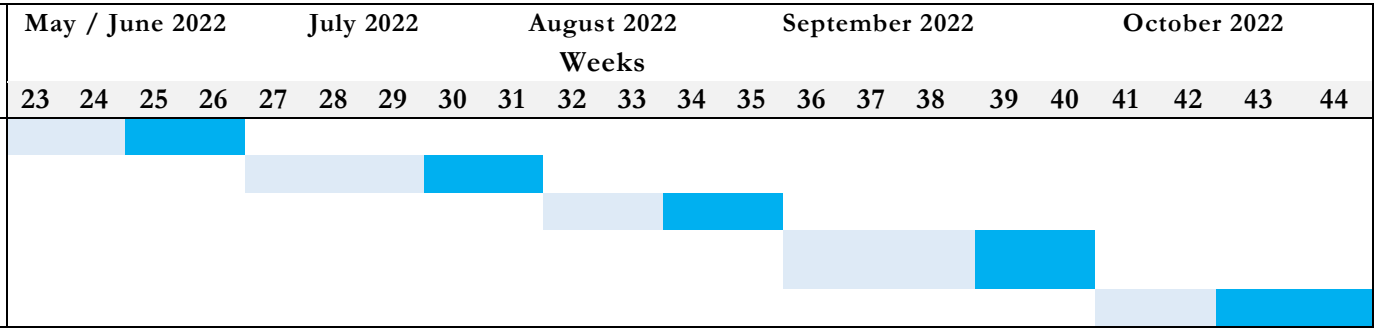
Annex 2. Timetable for COOMET.AUV.A-S4 Supplementary Comparison

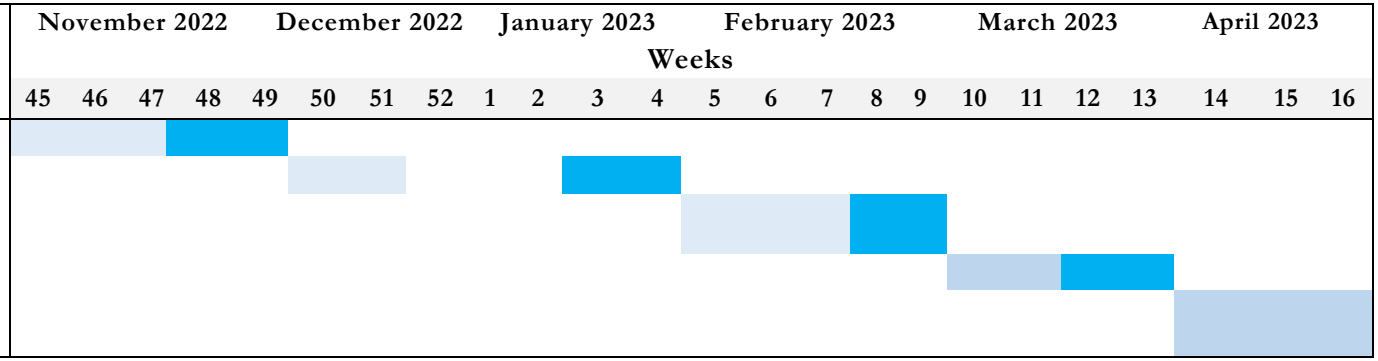
NMI/DI	Country	Receipt of sound calibrators	Final report deadline
TÜBİTAK UME	Turkey	17 Jan. 2022	4 March 2022
NMS	Lithuania	18 Febr. 2022	8 April 2022
TÜBİTAK UME	Turkey	25 March 2022	
NSAI NML	Ireland	22 April 2022	10 June 2022



NMI/DI	Country	Receipt of sound calibrators	Final report deadline
TÜBİTAK UME	Turkey	27 May 2022	
BFKH	Hungary	24 June 2022	12 Aug. 2022
TÜBİTAK UME	Turkey	29 July 2022	
DP NDI "Systema"	Ukraine	26 Aug. 2022	14 Oct. 2022
TÜBİTAK UME	Turkey	30 Sept. 2022	



NMI/DI	Country	Receipt of sound calibrators	Final report deadline
BelGIM	Belarus	28 Oct. 2022	16 Dec. 2022
TÜBİTAK UME	Turkey	1 Dec. 2023	
FSUE "VNIIFTRI"	Russia	27 Jan. 2023	17 March 2023
TÜBİTAK UME	Turkey	3 March 2023	
SASO NMCC	Saudi Arabia	31 March 2023	19 May 2023



NMI/DI	Country	Receipt of sound calibrators	Final report deadline	April		May 2023			June 2023				July 2023					August 2023					September 2023		
				Weeks																					
				17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
SASO NMCC	Saudi Arabia																								
TÜBİTAK UME	Turkey	5 May 2023																							
Reporting (Preparation of Draft A)			16 June 2023																						
Circulation of Draft A			23 June 2023																						

Annex 3.

Agreement to participate in COOMET.AUV.A-S4 Comparison

Name and address of laboratory

Contact person

Phone:
Name:
E-mail:

Methodology

☐ IEC 60942:2017 (microphone method)

☐ Other (please give details in the section "Additional Information" below

Scope

Device	Measurement quantities	Type of microphone
Pistonphone	☐ Sound Pressure ☐ Frequency ☐ Harmonic Distortion + noise	☐ LS1P ☐ LS2P ☐ Other

Device	Measurement quantities	Type of microphone
Sound Calibrator	☐ Sound Pressure ☐ Frequency ☐ Harmonic Distortion + noise	☐ LS1P ☐ LS2P ☐ Other

Will you require ATA Carnet?	☐ Yes	☐ No
The proposed date for participation is acceptable	☐ Yes	☐ No

Additional Information

Please return this form to pilot laboratory: enver.sadikoglu@tubitak.gov.tr

The pilot laboratory has distributed this form electronically to participating laboratories. A further copy is available by contacting enver.sadikoglu@tubitak.gov.tr

The completed form shall be returned to the pilot laboratory by **15 December 2021**.