

## GUM Activities in Acoustics and Vibration

### Brief Report for the 9th Meeting of CCAUV

As a result of the last reorganization of the structure of Central Office of Measures (GUM) Acoustics and Vibration Laboratory is now a part of the Radiation and Vibration Division. At present it employs 8 persons: 4 involved in acoustical and 4 in vibration measurements. Two persons have PhD degree, five MSc degree and one is auxiliary technical employee.

#### **1. Sound in Air**

The activity of the Laboratory in sound in air domain covers mainly the maintenance and development of national standard of sound pressure unit, primary and secondary calibration of measurement microphones, calibration of sound calibrators and audiometric equipment, pattern evaluation tests of sound level meters as well as calibration and periodic tests of sound level meters, personal sound exposure meters and band pass filters. Every year the Laboratory issues about 200 certificates for external customers. For some years the Laboratory has been involved in the development of facilities and measurement techniques concerning secondary calibration of acoustical instruments in low frequency range.

The national standard of sound pressure was significantly upgraded in 2009. The details of the upgrading were presented in the "Brief report on primary standards for acoustics and vibration at GUM" to the 7th Meeting of CCAUV (doc. CCAUV/10-22). The reciprocity setup used currently at the GUM fulfils the requirements of the IEC 61094-2:2009 standard and enables the calibration of microphones (both for sensitivity magnitude and phase) in the frequency range 2 Hz to 10 kHz (LS1 microphones) and 20 Hz to 25 kHz (LS2 microphones). It is used also for calibration of microphones from laboratories from outside GUM (including foreign laboratories) and for the calibration of GUM own reference microphones (8 LS1 and 7 LS2 microphones and a few WS microphones). Every year the Laboratory issues a few certificates for external customers and performs over 20 internal calibrations. In 2011 the Laboratory took part in the CCAUV.A-K5 key comparison for LS1 microphones and in 2013 in AFRIMETS.AUV.A-S1 regional comparison for LS2 microphones.

In 2012 the Laboratory extended its activity to the secondary pressure calibration of microphones by simultaneous comparison. The B&K Microphone Calibration System Type 9721 (with the Calibration Software type WT 9649) based on the 3560 B&K PULSE multianalyser has been bought and installed in the Laboratory. The system enables the determination of microphone sensitivity at one frequency (251 Hz or 1 kHz) by simultaneous comparison with a reference microphone using B&K WA0817 active coupler and the

determination of microphone frequency response using either the electrostatic actuator (where appropriate sound field corrections are available) or simultaneous comparison (for microphones where electrostatic actuator cannot be used). The measurements are consistent with EN 61094-5 or EN 61094-6 respectively. The best uncertainty of the calibration of LS2 microphones by comparison at 251 Hz is equal to 0,06 dB.

In the future the Laboratory intends to develop a facility for pressure calibration of microphones in the frequency range above 2 kHz in order to perform secondary pressure calibration with sufficiently low uncertainty in the frequency range up to 16 kHz.

Recently the setting-up of the system for calibration of ear simulators conformable to EN 60318-1 has been started. The calibration will cover:

- the testing of simulator acoustic transfer impedance for conformance to requirements of the standard mentioned above,
- the determination of the sensitivity of sound pressure measuring chain (measurement microphone connected to microphone preamplifier via the body of ear simulator).

The measurements are planned to be performed within frequency range 125 Hz to 8000 Hz at third-octave intervals including measurement frequencies used in audiometry. Presently following elements of the system are at the stage of design and workmanship:

- supply unit for measurement microphone to be used as sound source,
- mechanical components for transmitter microphone positioning at the inlet of ear simulator, allowing for LS1 or LS2 microphones to be used here,
- mechanical components allowing for attaching the sound source to ear simulator body during measurements.

Later the following work stages are intended to be performed:

- test measurements to verify if the system works correctly,
- modification of system components (if necessary),
- estimating of calibration uncertainty.

In 2012 as the response to the requirements of Polish institutions responsible for labour protection the Laboratory compiled the temporary recommendations regarding the equipment intended for the measurement of ultrasonic noise at work places, developed the methods and program of its periodic calibration as well as the methodology for estimating combined uncertainty of ultrasonic noise measurement related to recommended equipment.

## 2. Vibration

In the field of vibration the Laboratory is focused on the maintenance and development of national standard of mechanical vibration quantities (acceleration, velocity, displacement), primary and secondary calibration of vibration transducers (mainly accelerometers) and acceleration measuring chains, calibration of vibration calibrators and vibration meters including calibration (verification) of human vibration meters (HVM) according to ISO 8041:2005, chapter 13: Verification.

Every year the Laboratory in vibration domain issues about 150 certificates for external customers and performs over 25 internal calibrations.

The national standard of vibration quantities is the CS 18 P primary calibration system developed by SPEKTRA (Germany), installed in Laboratory in 2002. The system enables the absolute magnitude and phase calibration of accelerometers and acceleration measuring chains according to ISO 16063:11 (method 3) in the frequency range from 1 Hz to 10 kHz. The basic measurement set-up configuration involves the Endevco 2911 exciter generating vertical vibration from 5 Hz to 10 kHz. It was presented in the Brief report on primary standards for acoustics and vibration at GUM to the 7th Meeting of CCAUV (CCAUV/10-22).

Calibration capabilities in the frequency range from 10 Hz to 10 kHz have been confirmed in the CCAUV.V-K2 key comparison.

In 2010-2011 the frequency range of absolute calibration was extended down to 1 Hz by including the APS 500 exciter in the primary calibration system.

Expanded measurement uncertainties of absolute calibration within frequency range from 1 Hz to 100 Hz (horizontal direction) have been estimated as:

for magnitude

- . 0,7 % within frequency range from 1 Hz to 8 Hz,
- . 0,6 % from 10 Hz to 16 Hz,
- . 0,5 % from 20 Hz to 63 Hz,
- . 0,6 % from 80 Hz to 100 Hz.

for phase

- . 0,7° within frequency range from 5 Hz to 8 Hz,
- . 0,6° from 10 Hz to 16 Hz,
- . 0,7 ° from 20 Hz to 100 Hz.

To verify the calibration capabilities in the frequency range from 1 Hz to 100 Hz Laboratory took part in EURAMET.AUV.V-S1 comparison (report under preparation).

In 2013 Laboratory took decision of upgrading the measurement set-up for primary calibration. There were at least three reasons to upgrade the system:

- strong need to extend the frequency range of absolute calibration of the standard accelerometers down to at least 0,5 Hz,
- problems with zero-position maintenance of low frequency exciters,
- customers need to calibrate heavy transducers by absolute method.

The discussion with SPEKTRA company resulted in decision of including two Laboratory low frequency exciters (APS 500 and APS 113AB) in the primary calibration system. The upgrading is going to finish at the end of 2013. Laboratory expects to achieve as follows:

- both APS exciters will be equipped with zero position controllers and angular adjustments,
- APS113AB exciter will be mounted vertically to enable the calibration of heavy transducers in vertical direction,
- the software for primary calibration will be updated,
- the obsolete instruments will be replaced by the new models (e.g. power amplifiers).

Recently Laboratory is also involved in the development of the software for the secondary calibration of accelerometers, calibration of vibration calibrators and electrical and mechanical tests of HVM according to ISO 8041.

In 2012 the Laboratory took part in the EURAMET.AUV.V-S1 for primary low frequency calibration and in AFRIMETS.AUV.A-S3 for secondary calibration.