

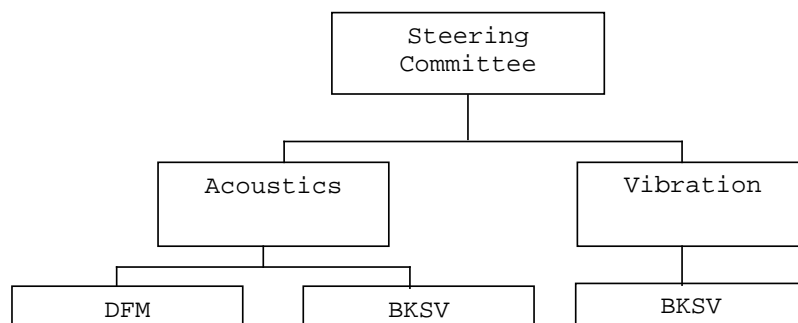
Joint Report of Activities from DFM and BKSVDPLA

Joint Report of Activities, October 2013

1. Introduction

The Danish Primary Laboratory of Acoustics (DPLA) is an entity co-operated by Brüel & Kjær S&V A/S (BKSVD) and Danish Fundamental Metrology Ltd. (DFM). DPLA has been nominated as Danish Primary Laboratory in the field of Acoustics in gases and solids by the Danish Safety Technology Authority (Sikkerhedsstyrelsen). In order to comply with the new structure required to participate in EURAMET, DPLA is represented by DFM as the Danish National Metrology Institute, and BKSVD-DPLA as Designated Institute.

The activities of DPLA are supervised by a Steering Group formed by staff from DFM and BKSVD; the members of the Steering Committee are Salvador Barrera-Figueroa, Michael Kjær, Erling Sandermann Olsen, Torben R. Licht, and Finn Kryger Nielsen. The organisational structure is shown in the block diagram below.



Further cooperation on research in acoustic metrology is maintained between DPLA and the Acoustic Technology group of the Institute of Electrical Engineering, Technical University of Denmark, and the ITI institute of the University of Southern Denmark.

DFM and BKSVD-DPLA are members of Daniamet. This is an umbrella organization that covers and coordinates multiple aspects of the decentralised Danish metrological infrastructure such as: fundamental metrology, legal metrology, and the network of primary and reference laboratories.

Acoustics is one of the four priority subject fields for Danish Metrology. This implies that acoustic metrology is undergoing a special effort for marketing and dissemination among the Danish acoustical community.

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Responsibilities

It is the responsibility of DPLA to maintain and disseminate the basic units in the field of Acoustics in gasses and solids and through research in the field to develop and improve methods for primary as well as secondary calibration. This responsibility is partially undertaken by offering services of microphone and accelerometer calibration at primary and secondary level. DPLA's services are accredited by DANAK (accr. 255 and 277). Secondary calibrations by comparison methods, performance testing and verification of acoustical measuring instruments are also performed by other accredited calibration laboratories in Denmark.

2. Activities in 2012-2013

Calibration activities

The combined annual number of certificates issued to external customers by DFM and BKSVDPLA in 2012-2013 on primary pressure reciprocity calibration of microphones is over 70 and over 100 on laser-calibration of accelerometers. In addition to the calibrations for customers a large number of internal microphone calibrations are performed to maintain the unit of sound pressure and for research and development activities. For this purpose DPLA holds a combined number of 19 B&K Type 4160 and 30 B&K Type 4180 microphones, which generally are calibrated each year. DPLA's partners hold four sets of reference accelerometers, including the associated preamplifiers, which are maintained and used as transfer standards. The four sets are calibrated every month.

Research activities

The major research activities on Acoustics in air are related to calibration of microphones by improving the calibration methods, extending the frequency range and the dynamic range of calibrations. New measurement techniques are also investigated, for instance opto-acoustic methods for characterising sound fields.

The activities on acoustics in solids have mainly been focused on refining the ISO16063-11 method 3 using off the shelf FFT analysers and extending the frequency range. Furthermore an effort has been made to include calibration at DC using the earth's gravitation.

Microphone calibration at DFM

Low-frequency calibration

Calibration of LS1 microphones to frequencies down to 2 Hz has been tested in the past, and DPLA participated in a Key Comparison (CCAUV-A.K2), and pressure calibration in this frequency range became a typical service of DFM. Additionally, the calibration of LS2 microphones down to 2 Hz was also implemented. An additional task will be to test whether WS2 microphones can also be calibrated using this technique.

In order to calibrate microphones below 2 Hz, and to validate the pressure reciprocity sensitivities an alternative method must be investigated, probably a laser pistonphone and a refined use of the electrostatic actuator. Once the methods are validated, calibrators for secondary calibration will be developed.

High-Frequency calibration

Recently, a system for free-field calibration of working standard microphones up to 150 kHz has successfully been implemented. The system is a modified version of the system used for calibration of LS microphones. The results of the free-field sensitivity have been validated against manufacturer data, and there is good agreement. Some issues concerning the use of adaptors in combination with driven and grounded shield configurations have been identified, and a solution is to be implemented in cooperation with BKS. Once this issue is resolved, a secondary method will be developed.

Optical techniques for sound measurement

An industrial PHD project awarded to DFM for the investigation of the application of the acousto-optic effect in the reconstruction of sound fields and other applications has focused on the reconstruction of sound fields using tomographic algorithms, beamforming, and acoustic holography. The results obtained will be used in the development of an acousto-optic based comparison calibrator for pressure calibration of standard microphones.

Microphone calibration at BKS-DPLA

Very low frequency calibration

A new method for measuring the frequency response of microphones at frequencies down to 0.1 Hz was developed. As the method has turned out to have higher uncertainty than expected, further research is being made on independent measurements at the lowest frequencies. The aim is to refine the method in order to establish a calibration service.

Low-frequency calibration

Calibration of LS1 microphones to frequencies down to 2 Hz has been developed, and BKS-DPLA is participating in a Key Comparison (CCAUV-A.K5). The preliminary results of the key comparison and the work with the calibrations has raised doubt on the corrections recommended in the international standard governing the measurements. This has initiated further research in the corrections. The work is close to a conclusion.

Vibration transducer calibration at BKSVDPLA

Extended frequency range for vibration transducer calibration

ISO16063-11 method 3 has been implemented using quadrature output laser interferometers to cover low frequency vibration transducer calibration down to 0.1 Hz and high frequency calibration up to 100 kHz but limited by the mechanical properties of the exciters and transducers. During 2007 funding has been found to establish such a system at DPLA. This system has now been accredited in the range 10 Hz to 10 kHz and is expected to be extended down to 0.1 Hz dynamically and also at DC using Earth's gravity later this year. Focus has been on getting the systems to operate smoothly and precisely.

International cooperation

The two Institutes of DPLA are active players in the global cooperation in CCAUV and in the regional cooperation within EURAMET. A member of DFM held the Chair of EURAMET's TCAUV until May 2013.

Staff members of DPLA are active members of IEC TC29 and ISO 108/SC3 in which they act as specialists and project leaders for specific standards. A member of BKSVDPLA staff is chairman of ISO 108/SC3.

DFM has acted as co-pilot laboratory for the Supplementary Comparison EURAMET.AUV.A-S1, concerned with calibration of LS1 and LS2 microphones. The comparison has finished, and the report published in the KCDB.

BKSVDPLA is participating in the Key Comparison CCAUV.A-K5, dealing with calibration of LS1 microphones in both Modulus and Phase at frequencies down to 2 Hz.

DFM is participating in the Regional Supplementary Comparison AFRI-METS.AUV.A-S1 concerned with pressure calibration of LS2 microphones.

BKSVDPLA participates in the EURAMET project 1056, Comparison of methods to determine corrections to obtain the free-field response of a sound level meter. The final report has been published in the EURAMET homepage.

BKSVDPLA has also participated in the Key Comparison CCAUV.V-K2 (10 Hz to 10 kHz) for which the final report is due at the CCAUV meeting, and in EURAMET.AUV.V-S1 (0 Hz to 200 Hz) for which the measurements are made and the report is due soon.