

CASE STUDY

Kingdom of Thailand

National Institute of Metrology – Bangkok, Thailand Calibration of Reference Standard Microphones

Metrology

Reciprocity Calibration System

The National Institute of Metrology was established in Thailand following the enactment of the “National Metrological System Development Act” in 1997.

Under this Act, The National Institute of Metrology, Thailand is empowered to develop metrology systems and procedures, and to maintain national and reference standards.

One of the many specified reference standards relates to the calibration of Reference Standard Microphones. In 2002, Brüel & Kjær supplied NIMT with a complete microphone reciprocity calibration system, including on-site installation and training.



Metrology

According to the dictionary, metrology is the science that relates to measurement. There are many parameters – one is the maintenance of acoustic reference standards by many countries around the world. The precision of acoustic measurements is based on Reference Standard Microphones calibrated by National Metrology Institutes (NMIs).

Measurement Accuracy

All National Metrology Institutes throughout the world are constantly striving to further increase the accuracy of measurements. There is attention to such aspects as calibration uncertainty, calibration reproducibility and the long-term stability of reference standards. Today, highly repeatable calibrations with an accuracy of 0.01 dB or better can be performed by many NMIs, while some NMIs specify uncertainties as low as 0.025 dB. This puts a focus on the stability of standard microphones.

Calibration of Laboratory Standard Microphones

The stability of microphones must meet the requirements and the practical needs of IEC 61094-1. The reciprocity calibration method described in IEC 61094-2 is applied for the determination of the microphone pressure sensitivity. The method requires three reciprocal microphones. The microphones are operated pair-wise, as a sound source and as a receiver in a setup where they are coupled together via the air inside a small cavity. The cavity acts as an acoustic transmission line with known properties. The three transfer impedances (receiver output voltage divided by transmitter input current) which are measured are used for the calculation of the three microphone sensitivities.

Brüel & Kjær, a founder member of Danish Primary Laboratory of Acoustics (DPLA), has supplied over twenty microphone calibration systems including more than fifteen to National Primary Calibration Laboratories throughout the world.

The National Institute of Metrology, Thailand

Fig. 1
An artist's impression of NIMT's impressive new facility that will be opened in 2005. It will extend to some 13 000 m²



Fig. 2
A model of NIMT's new site north of Bangkok – superb architecture in an idyllic setting



The National Institute of Metrology, Thailand (NIMT) was established following the enactment of the National Metrological System Development Act, B.E. 2540 (1997). The Chairman of the National Metrology Board is nominated and reports to the Minister of Science and Technology.

Following its establishment, all metrological responsibilities of the Department of Science Service (DSS) and the Thailand Institute of Scientific Technological Research (TISTR) were transferred to NIMT and it began operations on 1st June, 1998.

NIMT's facility, with about 100 employees, is currently located in Bangkok. A decision has recently been made to construct a new complex of about 13 000 m² to house the Institute. This will be located some 50 km north of Bangkok and will be opened in 2005. With these increased facilities, the number of employees is expected to rise to about 150.

Metrological Experience

Fig. 3
Mr. Virat Plangsangmas is head of NIMT's acoustic/vibration laboratory



Mr. Virat Plangsangmas is head of NIMT's acoustic/vibration laboratory. He has worked at NIMT for about four years and has a Master's degree in Product Assurance Engineering from the University of Central Florida, USA. He was previously employed at the Thailand Institute of Scientific and Technological Research (TISTR) for fifteen years, and, as an engineer (level 7) was in charge of testing a wide variety of electrical appliances to ensure confirmation to established specifications. Mr. Virat was trained in acoustics and noise abatement for 14 months at PTB and TÜV in Germany. Mr. Virat has a staff of three and some of his colleagues have over four years of acoustical experience.

Mr. Virat explains, "NIMT is responsible for maintaining national metrological standards in many areas. One of these is the primary calibration of reference microphones. In addition to maintaining the primary microphone calibration standard for Thailand, NIMT calibrates the reference microphones for lower level laboratories. We also calibrate other acoustical equipment including calibrators, sound level meters, etc., to a series of worldwide IEC standards. We aim to maintain the temperature of the laboratory at $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$. The humidity level is harder to control and research shows that this does not significantly affect the accuracy of measurements".

Fig. 4
Ms. Surat Pattarachindanuwong works with the Reciprocity Calibration system at NIMT. She has a Master's degree in Industrial Metrology from King Mongkut's University of Technology Thonburi



Mr. Virat continues, "We have used Brüel & Kjær products at the Thailand Institute of Scientific and Technological Research for more than ten years. Brüel & Kjær is unique in supplying systems for the primary calibration of microphones and this, together with our need to buy an automated system to facilitate our primary calibration work, made the decision an easy one. A big benefit was that we had the calibration system installed and fully operational in a very short time. It was good to have the training from Brüel & Kjær and their approach was very systematic".

"The primary acoustic calibration is made on half-inch microphones (Brüel & Kjær Type 4180) and one-inch microphones (Brüel & Kjær Type 4160). We have a total of about ten of these primary calibration standard microphones and our intention is to take some of these to the NMIs of other countries such as DPLA, Singapore, Australia, etc., to verify the accuracy of our measurements or to participate in some of the inter-laboratory comparison programs", says Mr. Virat.

Following calibration of a microphone, NIMT prepares a printed report. The report shows the measurements made, the calculated level of uncertainty, and describes the methodology used, in accordance with IEC standards. The report is signed on behalf of the Director of NIMT. The measurement data must be kept for six years and is archived in both paper format and on CD.

NIMT also has a specially designed and built anechoic room with a 50 Hz cut-off. A Brüel & Kjær Analyzer Type 2133 is used for microphone calibration comparison measurements. Other Brüel & Kjær equipment is used for a variety of acoustical measurement tasks including material testing, and the calibration of sound level meters.

Fig. 5

Left: A Brüel & Kjær Analyzer Type 2133 for calibration comparison
Right: Material Testing setup



Danish Primary Laboratory of Acoustics

Under the auspices of the DANIAMet Secretariat (Danish Institute of Fundamental Metrology), The Danish Primary Laboratory of Acoustics (DPLA) was founded in 1991 by Brüel & Kjær and the Laboratory of Acoustics at the Technical University of Denmark, Lyngby. The Brüel & Kjær part of DPLA is operated, within Brüel & Kjær, as a separate and independent department which has full autonomy in all technical questions.

The software used in Reciprocity Calibration Apparatus Type 9699 was jointly developed by Brüel & Kjær and the Technical University of Denmark.

DPLA offers the calibration of microphones and accelerometers which serve as Reference Standards and Working Standards for measurement laboratories and other users within the field of acoustics. To make sure that any calibration is performed correctly, one DPLA Reference Microphone with known sensitivity is always used as one of the three microphones.

DPLA uses standards from leading primary laboratories to compare with its absolute calibrations, and is responsible for the coordination of acoustic calibrations from laboratories throughout the world.

Key Facts

- The maintenance of acoustic reference standards is based on Reference Standard Microphones calibrated by National Metrology Institutes
- The National Institute of Metrology, Thailand (NIMT) was established in 1997
- Brüel & Kjær supplied NIMT with a complete microphone reciprocity calibration system, including on-site installation and training
- Highly repeatable calibrations with an accuracy of 0.01 dB or better can be performed
- NIMT currently has about 100 employees, and is located in Bangkok
- A new facility, 50 km north of Bangkok, will be opened in 2005
- NIMT calibrates the reference microphones for lower level laboratories in Thailand
- NIMT also calibrates other acoustical equipment including calibrators, sound level meters, etc.
- “Brüel & Kjær is unique in supplying systems for the primary calibration of microphones”
- “A big benefit was that we had the calibration system installed and fully operational in a very short time”